FIG. 1

GENERAL EXPRESSION OF WAVELET TRANSFORM

<CONTINUOUS WAVELET>

FORWARD TRANSFORM $W_\psi(a,b)=\frac{1}{\sqrt{a}}\int_{-\infty}^{\infty} f(t)\psi_{a,b}(t)\,dt$ (EXPRESSION 1)

INVERSE TRANSFORM $f(t)=\frac{2}{C_\psi}\iint_{\Re^2} W_\psi(a,b)\psi_{a,b}(t)\frac{dbda}{a^2}$ (EXPRESSION 2)

$\psi_{a,b}(x)=\frac{1}{\sqrt{a}}\psi\left(\frac{x-b}{a}\right)$ (EXPRESSION 3)

$C_\psi=\int_{-\infty}^{\infty}\frac{|\hat{\psi}(\omega^2)|}{|\omega|}d\omega$ (EXPRESSION 4)

$\Re$: REAL NUMBER

$\hat{\Psi}(\omega)$ IS FOURIER TRANSFORM OF $\Psi(X)$

a : SCALE PARAMETER

b : SHIFT PARAMETER

<DISCRETE WAVELET>

GIVEN $a=2^j$, $b=2^j k$ $(j>0)$,

FORWARD TRANSFORM $w_k^{(j)}=2^{\frac{j}{2}}\sum_t f(t)\psi_{j,k}(t)$ (EXPRESSION 5)

INVERSE TRANSFORM $f(t)=\sum_j\sum_k w_k^{(j)}\psi_{j,k}(t)$ (EXPRESSION 6)

$\psi_{j,k}(x)=\psi(2^j x-k)$ (EXPRESSION 7)

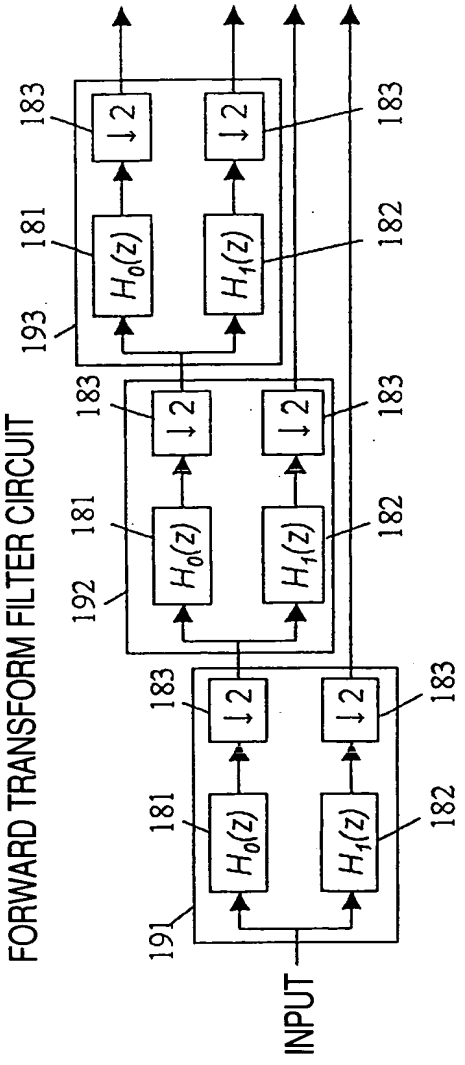

FORWARD TRANSFORM FILTER CIRCUIT
INPUT
$H_0(z)$
$H_1(z)$
↓2
181
182
183
191
192
193

FIG. 2(a)

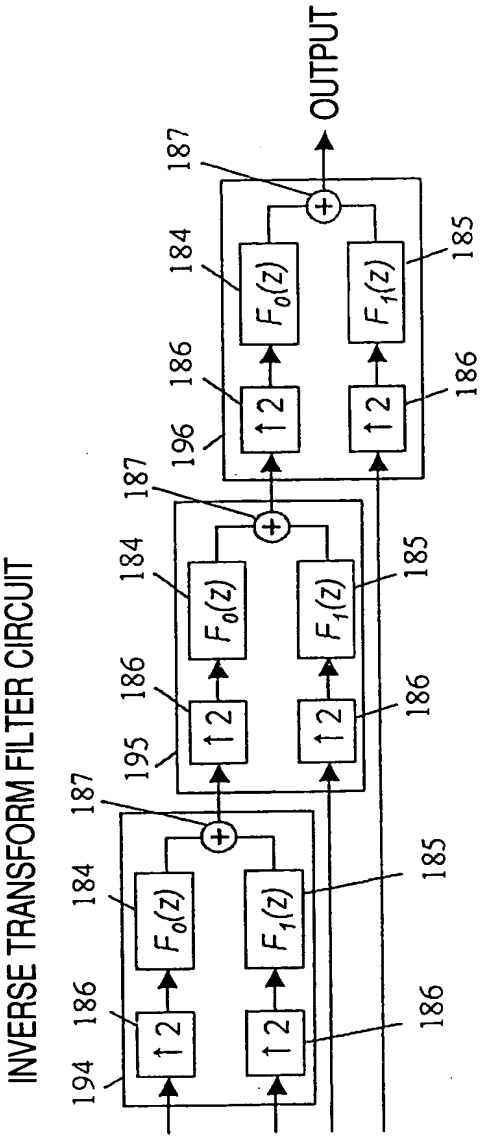
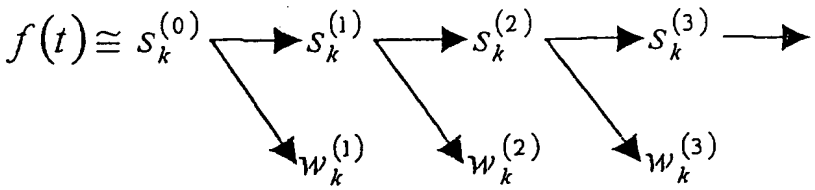

INVERSE TRANSFORM FILTER CIRCUIT
OUTPUT
$F_0(z)$
$F_1(z)$
↑2
184
185
186
187
194
195
196

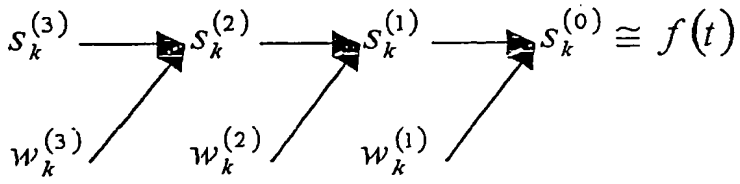
FIG. 2(b)

FIG. 3(a)



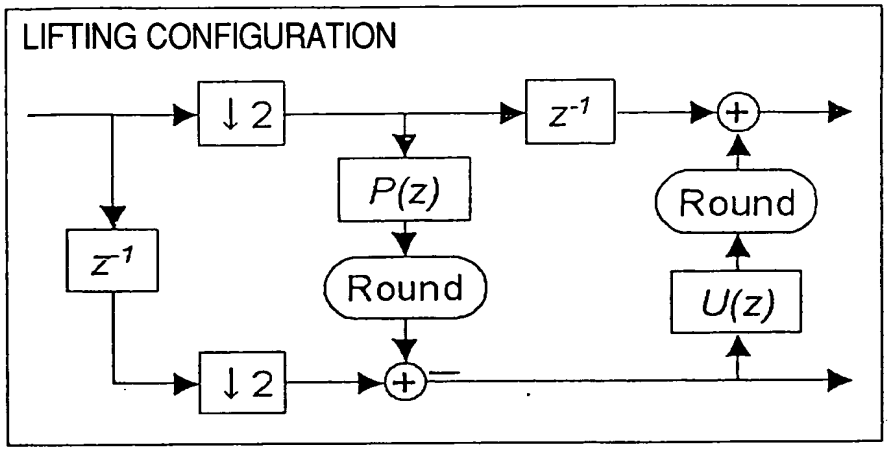
SIGNAL DECOMPOSITION IN FOWARD TRANSFORM

FIG. 3(b)



SIGNAL RECONSTRUCTION IN INVERSE TRANSFORM

FIG. 4(a)



$$P(z) = \frac{1 + z^{-1}}{2}$$

$$U(z) = \frac{1 + z^{-1}}{4}$$

FIG. 4(b)

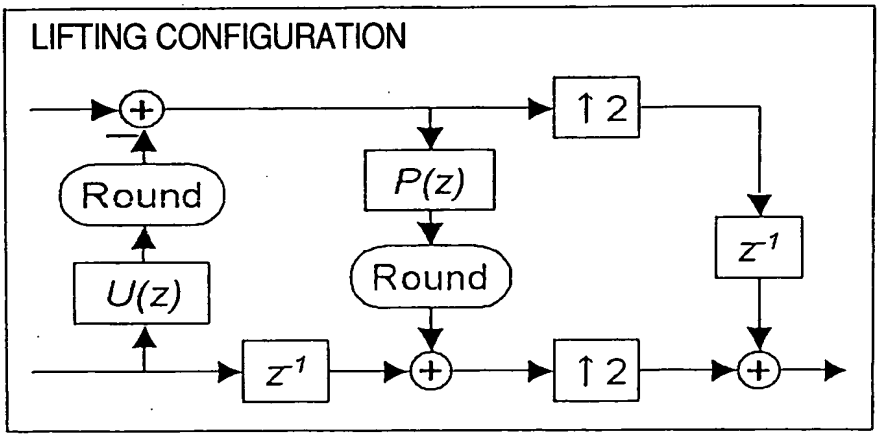


FIG. 5

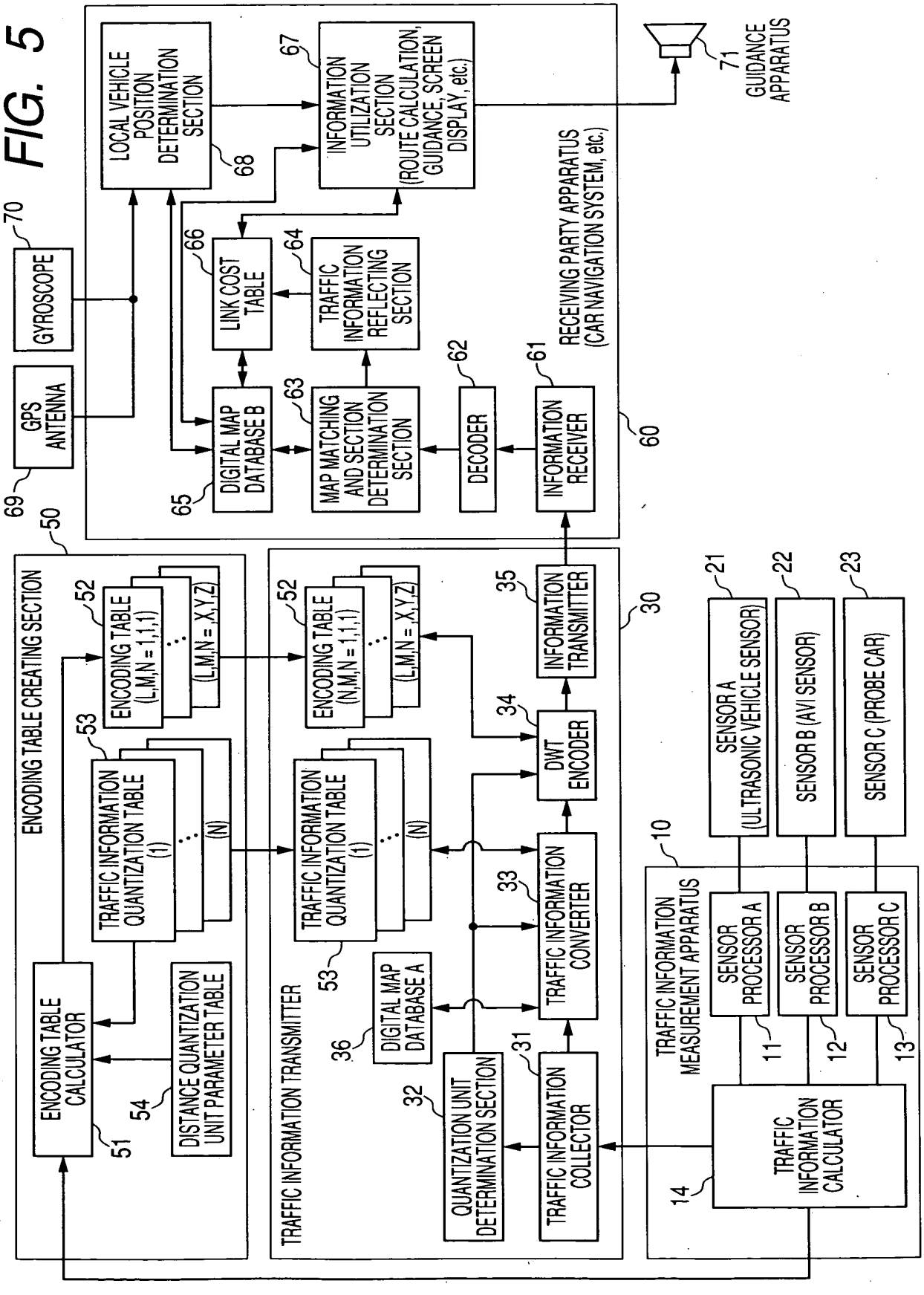

ENCODING TABLE CREATING SECTION
50
ENCODING TABLE CALCULATOR
51
DISTANCE QUANTIZATION UNIT PARAMETER TABLE
54
TRAFFIC INFORMATION QUANTIZATION TABLE (1) ... (N)
53
ENCODING TABLE (L,M,N = 1,1,1) ... (L,M,N = X,Y,Z)
52
TRAFFIC INFORMATION TRANSMITTER
30
DIGITAL MAP DATABASE A
36
QUANTIZATION UNIT DETERMINATION SECTION
32
TRAFFIC INFORMATION COLLECTOR
31
TRAFFIC INFORMATION CONVERTER
33
DWT ENCODER
34
INFORMATION TRANSMITTER
35
TRAFFIC INFORMATION MEASUREMENT APPARATUS
10
SENSOR PROCESSOR A
11
SENSOR PROCESSOR B
12
SENSOR PROCESSOR C
13
TRAFFIC INFORMATION CALCULATOR
14
SENSOR A (ULTRASONIC VEHICLE SENSOR)
21
SENSOR B (AVI SENSOR)
22
SENSOR C (PROBE CAR)
23
RECEIVING PARTY APPARATUS (CAR NAVIGATION SYSTEM, etc.)
60
INFORMATION RECEIVER
61
DECODER
62
MAP MATCHING AND SECTION DETERMINATION SECTION
63
TRAFFIC INFORMATION REFLECTING SECTION
64
DIGITAL MAP DATABASE B
65
LINK COST TABLE
66
INFORMATION UTILIZATION SECTION (ROUTE CALCULATION, GUIDANCE, SCREEN DISPLAY, etc.)
67
LOCAL VEHICLE POSITION DETERMINATION SECTION
68
GPS ANTENNA
69
GYROSCOPE
70
GUIDANCE APPARATUS
71

FIG. 6

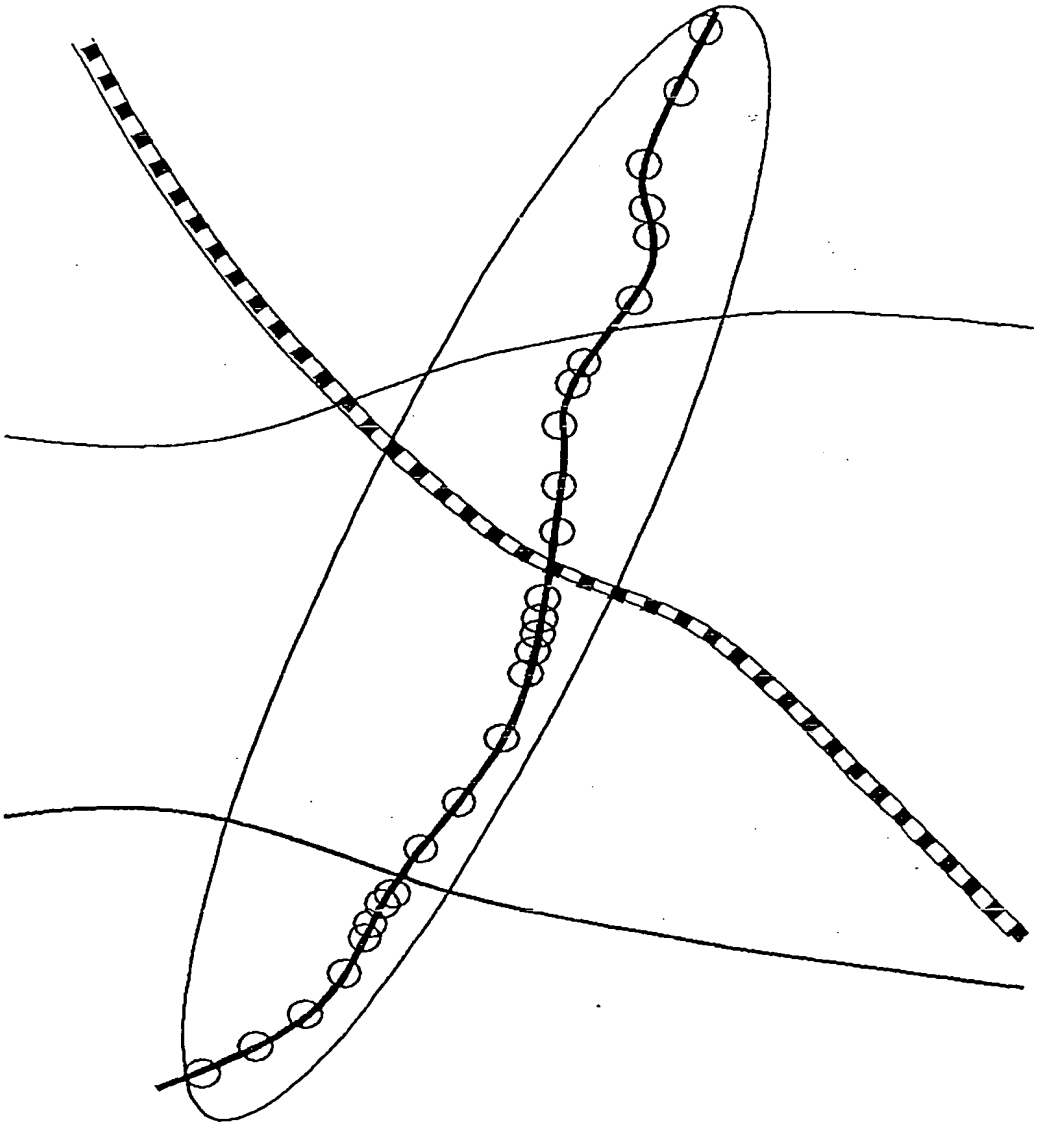


FIG. 7

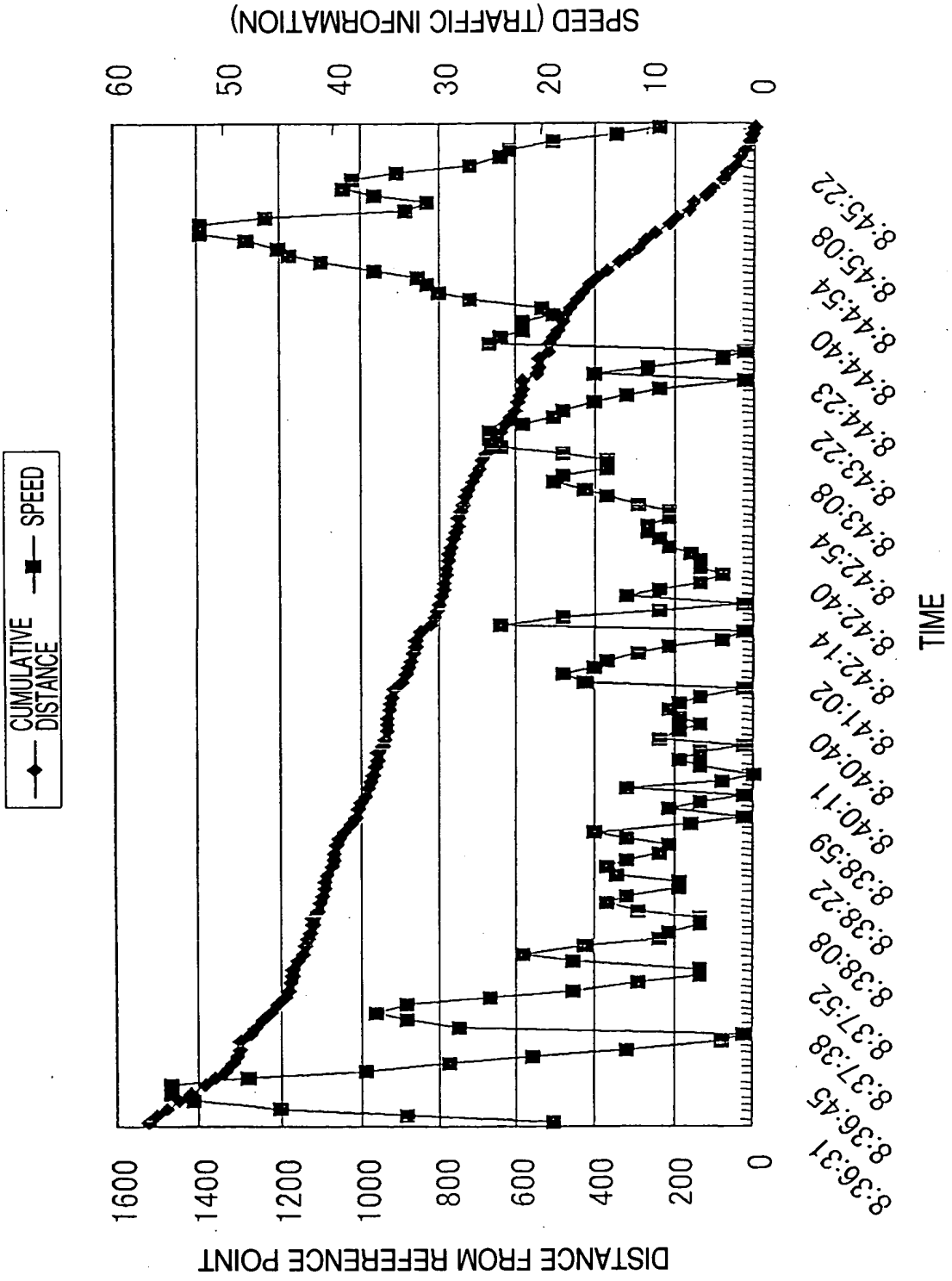

CUMULATIVE DISTANCE
SPEED
SPEED (TRAFFIC INFORMATION)
0
10
20
30
40
50
60
DISTANCE FROM REFERENCE POINT
0
200
400
600
800
1000
1200
1400
1600
TIME
8:36:31
8:36:45
8:37:38
8:37:52
8:38:08
8:38:22
8:38:59
8:40:11
8:40:40
8:41:02
8:42:14
8:42:40
8:42:54
8:43:08
8:43:22
8:44:23
8:44:40
8:44:54
8:45:08
8:45:22

FIG. 8

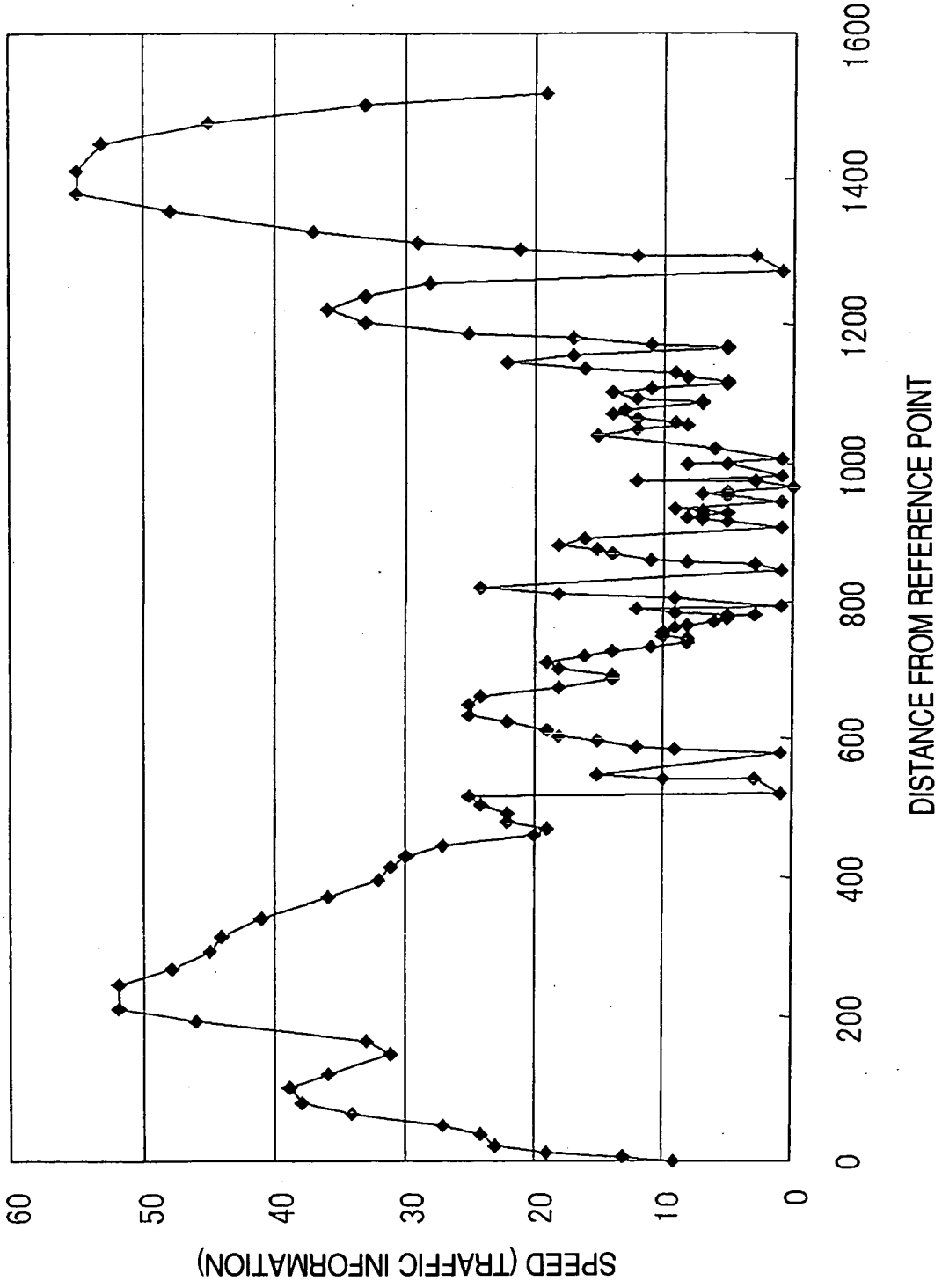

SPEED (TRAFFIC INFORMATION)
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
DISTANCE FROM REFERENCE POINT

FIG. 9

CONGESTION RANK	BEGINNING OF CONGESTION	END OF CONGESTION
1 (10km/h)	0m FROM THE END OF LINK A	900m FROM THE END OF LINK A
3 (40km/h)	900m FROM THE END OF LINK A	BEGINNING OF LINK A
2 (20km/h)	0m FROM THE END OF LINK B	300m FROM THE END OF LINK B
3 (40km/h)	300m FROM THE END OF LINK B	TO BEGINNING OF LINK B

LINK LENGTH
LINK A: 1100m
LINK B: 400m

FIG. 10

○○～△△	20 MINUTES
△△～□□	12 MINUTES
□□～××	30 MINUTES

FIG. 11

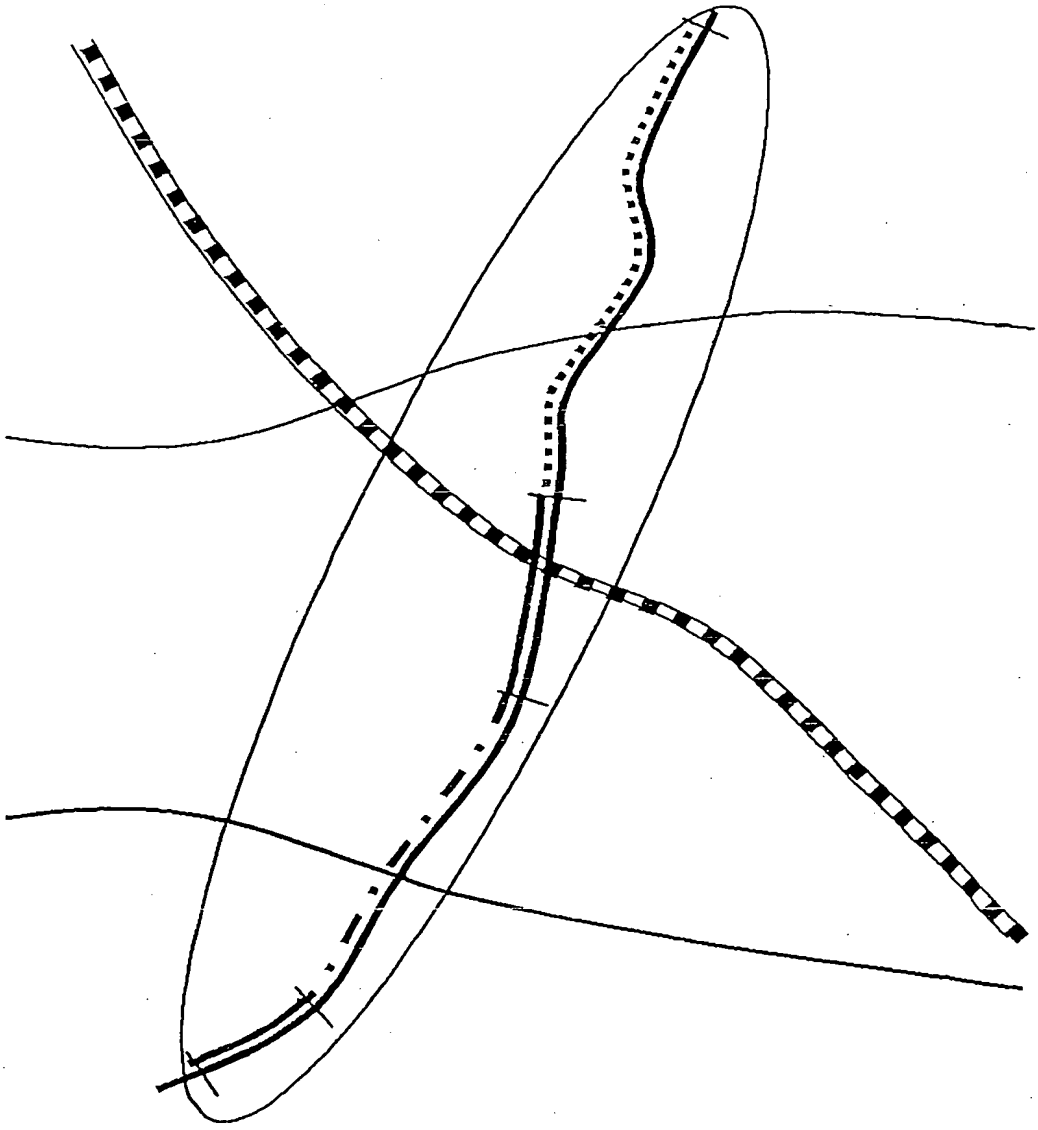


FIG. 12

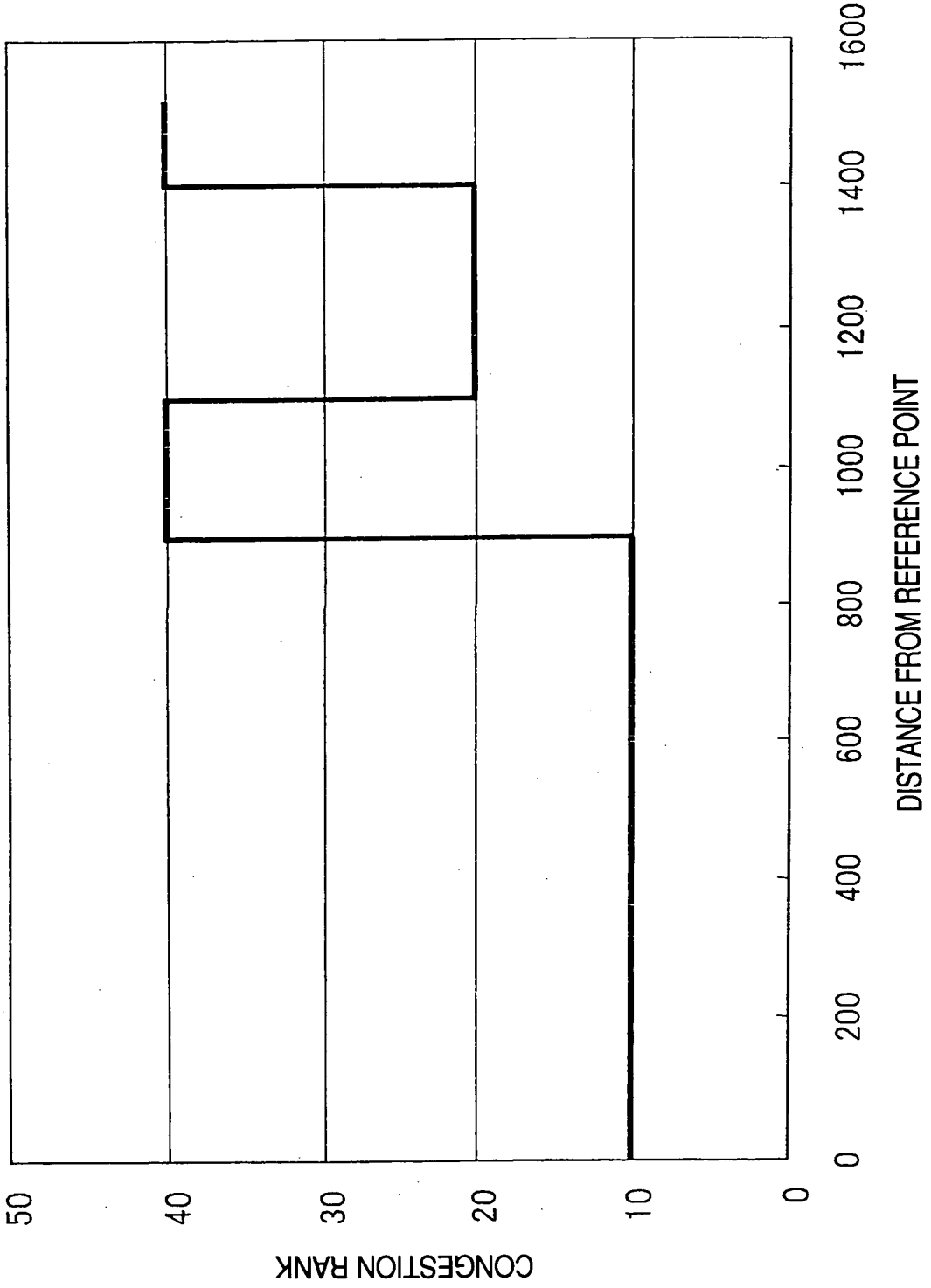

CONGESTION RANK
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
DISTANCE FROM REFERENCE POINT

FIG. 13

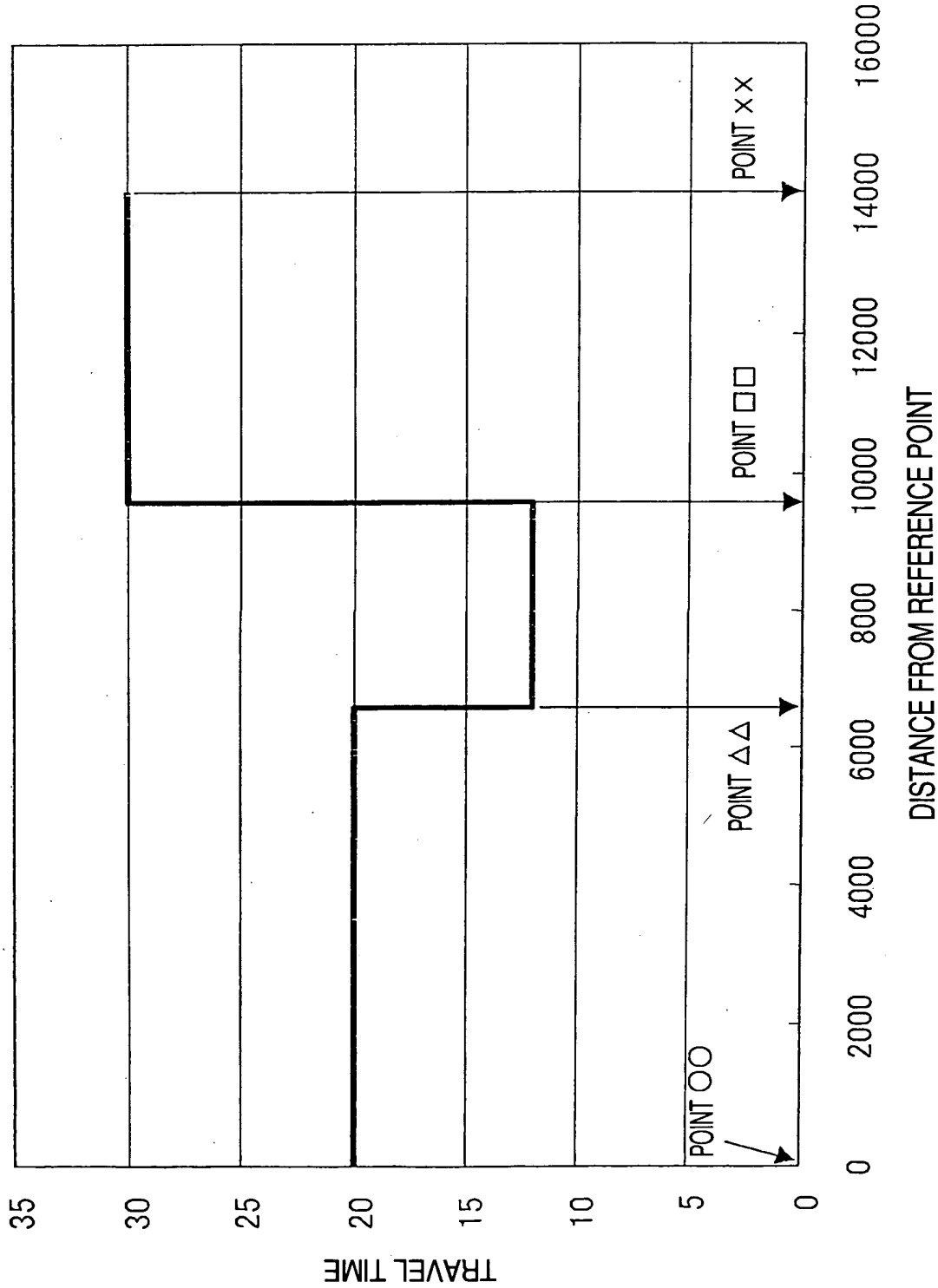

TRAVEL TIME
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
12000
14000
16000
DISTANCE FROM REFERENCE POINT
POINT OO
POINT ΔΔ
POINT □□
POINT ××

FIG. 14

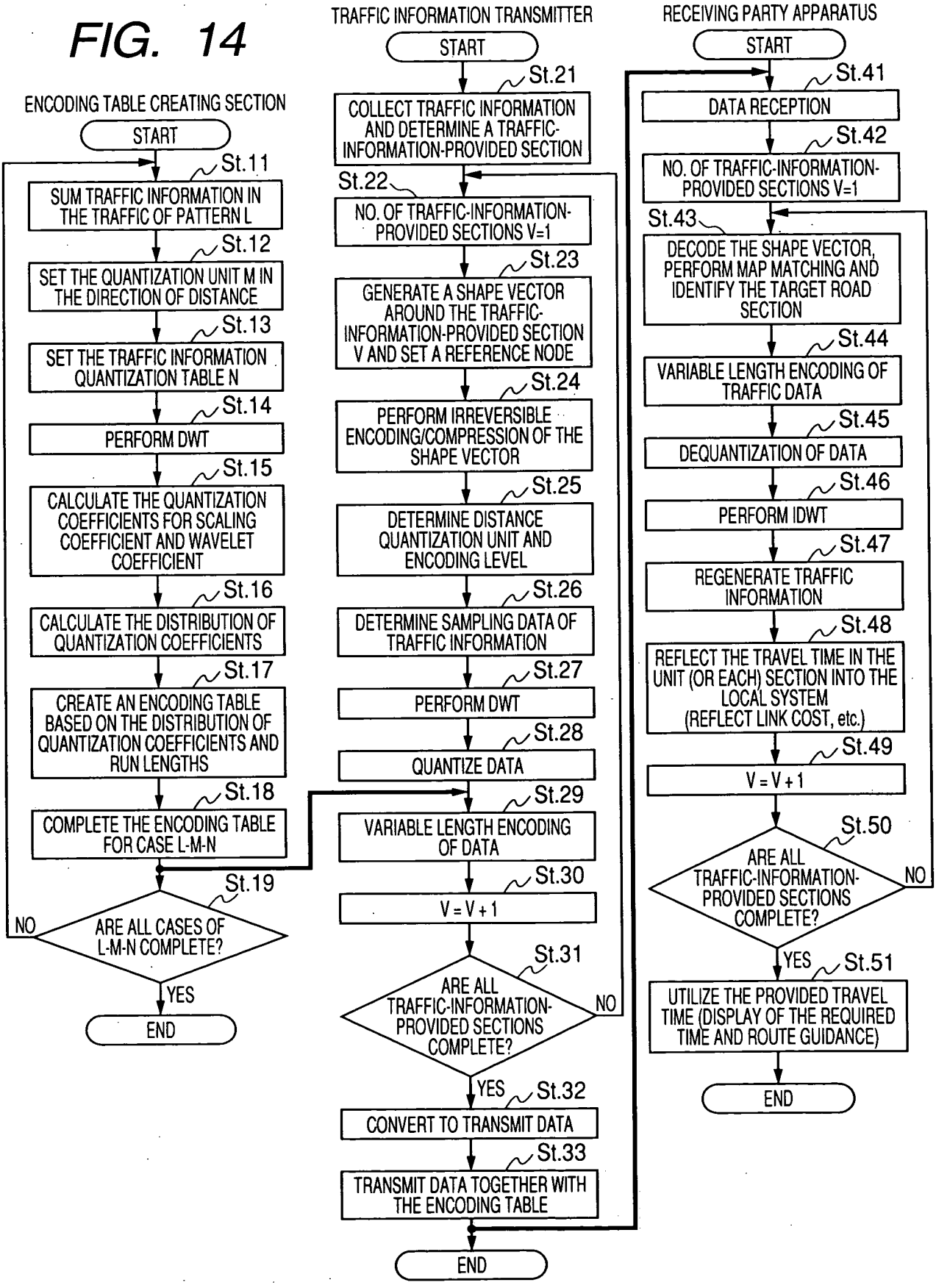

ENCODING TABLE CREATING SECTION
START
St.11
SUM TRAFFIC INFORMATION IN THE TRAFFIC OF PATTERN L
St.12
SET THE QUANTIZATION UNIT M IN THE DIRECTION OF DISTANCE
St.13
SET THE TRAFFIC INFORMATION QUANTIZATION TABLE N
St.14
PERFORM DWT
St.15
CALCULATE THE QUANTIZATION COEFFICIENTS FOR SCALING COEFFICIENT AND WAVELET COEFFICIENT
St.16
CALCULATE THE DISTRIBUTION OF QUANTIZATION COEFFICIENTS
St.17
CREATE AN ENCODING TABLE BASED ON THE DISTRIBUTION OF QUANTIZATION COEFFICIENTS AND RUN LENGTHS
St.18
COMPLETE THE ENCODING TABLE FOR CASE L-M-N
St.19
ARE ALL CASES OF L-M-N COMPLETE?
NO
YES
END
TRAFFIC INFORMATION TRANSMITTER
START
St.21
COLLECT TRAFFIC INFORMATION AND DETERMINE A TRAFFIC-INFORMATION-PROVIDED SECTION
St.22
NO. OF TRAFFIC-INFORMATION-PROVIDED SECTIONS V=1
St.23
GENERATE A SHAPE VECTOR AROUND THE TRAFFIC-INFORMATION-PROVIDED SECTION V AND SET A REFERENCE NODE
St.24
PERFORM IRREVERSIBLE ENCODING/COMPRESSION OF THE SHAPE VECTOR
St.25
DETERMINE DISTANCE QUANTIZATION UNIT AND ENCODING LEVEL
St.26
DETERMINE SAMPLING DATA OF TRAFFIC INFORMATION
St.27
PERFORM DWT
St.28
QUANTIZE DATA
St.29
VARIABLE LENGTH ENCODING OF DATA
St.30
V = V + 1
St.31
ARE ALL TRAFFIC-INFORMATION-PROVIDED SECTIONS COMPLETE?
NO
YES
St.32
CONVERT TO TRANSMIT DATA
St.33
TRANSMIT DATA TOGETHER WITH THE ENCODING TABLE
END
RECEIVING PARTY APPARATUS
START
St.41
DATA RECEPTION
St.42
NO. OF TRAFFIC-INFORMATION-PROVIDED SECTIONS V=1
St.43
DECODE THE SHAPE VECTOR, PERFORM MAP MATCHING AND IDENTIFY THE TARGET ROAD SECTION
St.44
VARIABLE LENGTH ENCODING OF TRAFFIC DATA
St.45
DEQUANTIZATION OF DATA
St.46
PERFORM IDWT
St.47
REGENERATE TRAFFIC INFORMATION
St.48
REFLECT THE TRAVEL TIME IN THE UNIT (OR EACH) SECTION INTO THE LOCAL SYSTEM (REFLECT LINK COST, etc.)
St.49
V = V + 1
St.50
ARE ALL TRAFFIC-INFORMATION-PROVIDED SECTIONS COMPLETE?
NO
YES
St.51
UTILIZE THE PROVIDED TRAVEL TIME (DISPLAY OF THE REQUIRED TIME AND ROUTE GUIDANCE)
END

FIG. 15

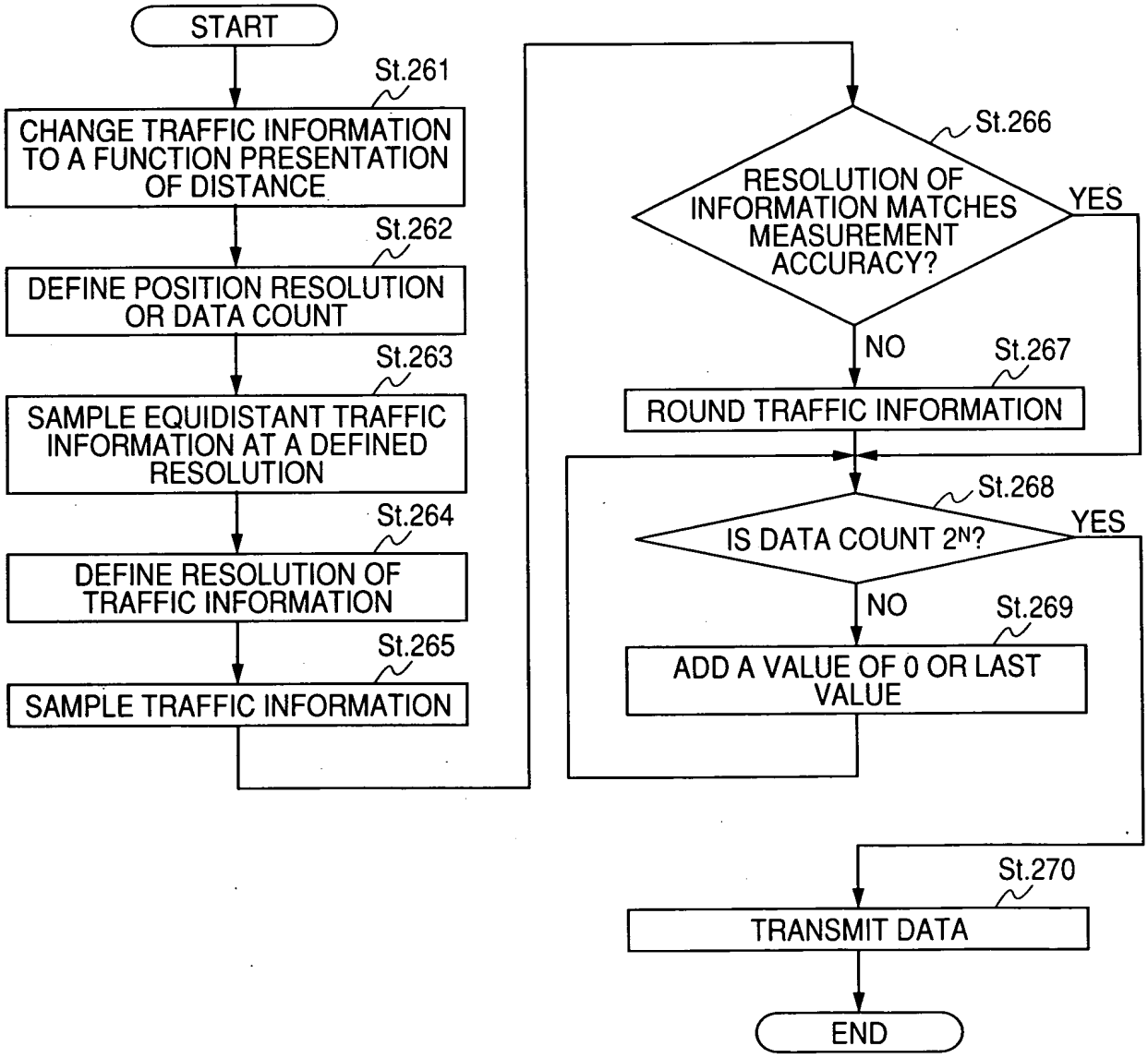

START
St.261
CHANGE TRAFFIC INFORMATION TO A FUNCTION PRESENTATION OF DISTANCE
St.262
DEFINE POSITION RESOLUTION OR DATA COUNT
St.263
SAMPLE EQUIDISTANT TRAFFIC INFORMATION AT A DEFINED RESOLUTION
St.264
DEFINE RESOLUTION OF TRAFFIC INFORMATION
St.265
SAMPLE TRAFFIC INFORMATION
St.266
RESOLUTION OF INFORMATION MATCHES MEASUREMENT ACCURACY?
YES
NO
St.267
ROUND TRAFFIC INFORMATION
St.268
IS DATA COUNT 2N?
YES
NO
St.269
ADD A VALUE OF 0 OR LAST VALUE
St.270
TRANSMIT DATA
END

FIG. 16

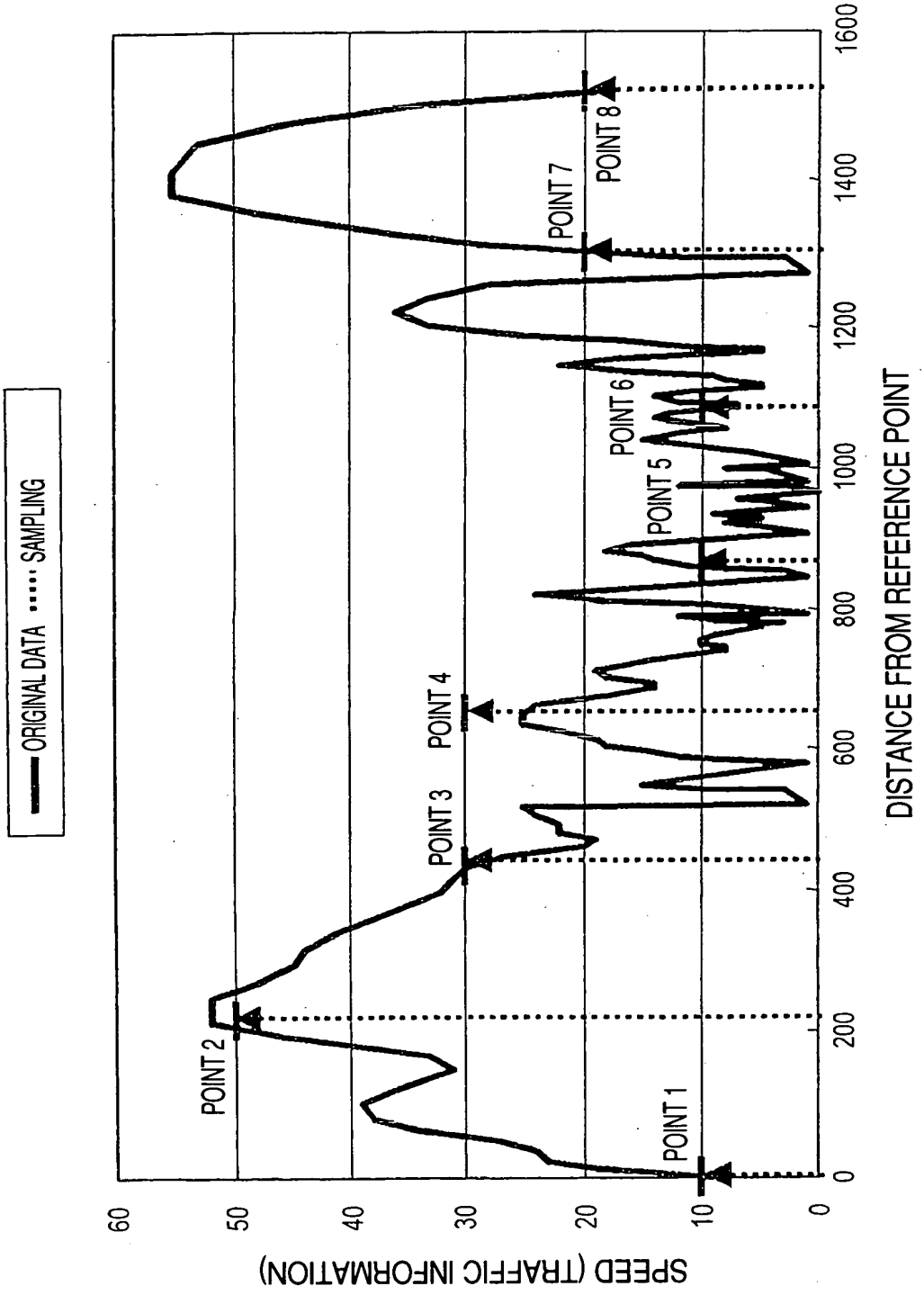

ORIGINAL DATA
SAMPLING
SPEED (TRAFFIC INFORMATION)
DISTANCE FROM REFERENCE POINT
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
1600
POINT 1
POINT 2
POINT 3
POINT 4
POINT 5
POINT 6
POINT 7
POINT 8

FIG. 17

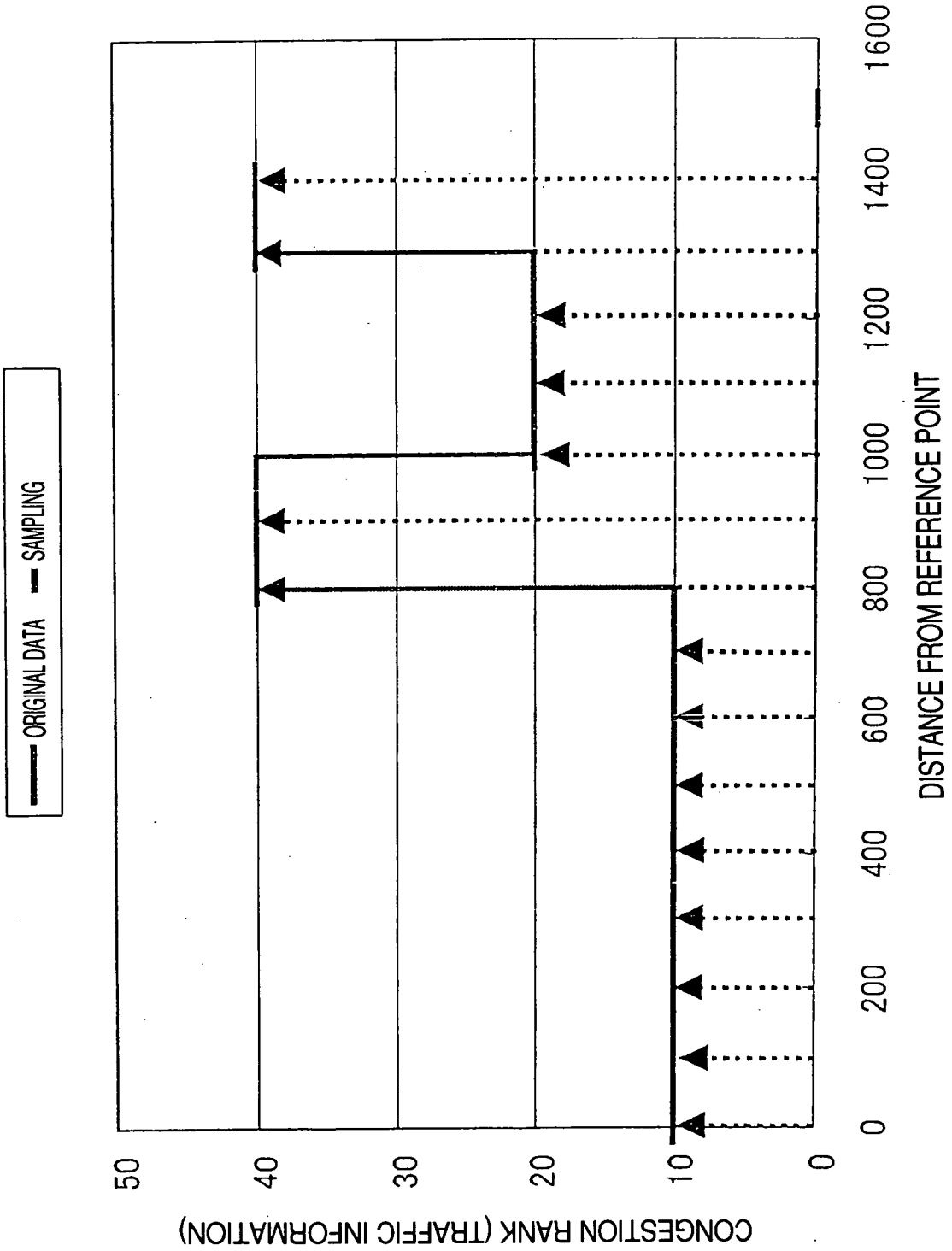

ORIGINAL DATA
SAMPLING
CONGESTION RANK (TRAFFIC INFORMATION)
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
DISTANCE FROM REFERENCE POINT

FIG. 18

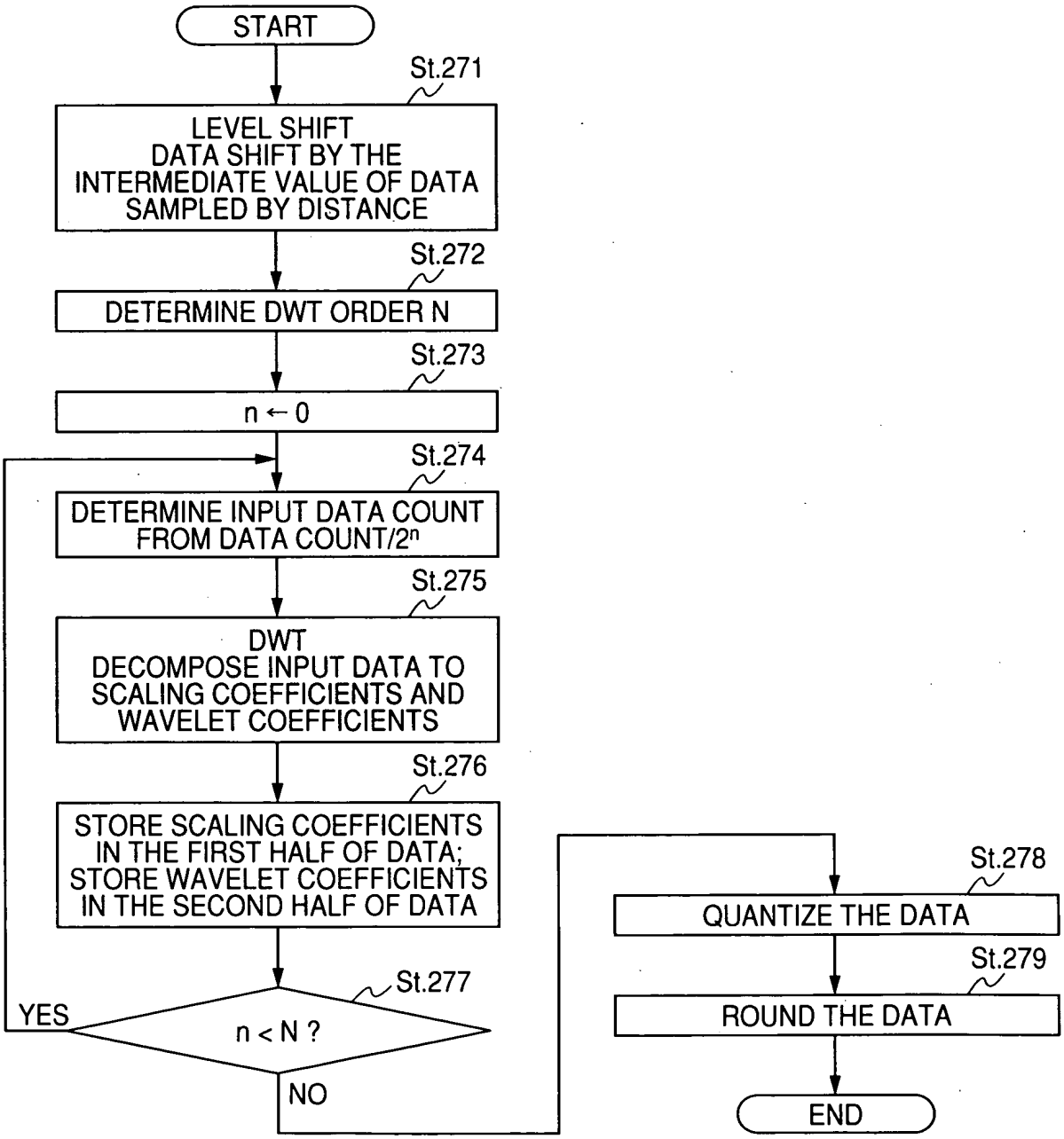

START
St.271
LEVEL SHIFT
DATA SHIFT BY THE INTERMEDIATE VALUE OF DATA SAMPLED BY DISTANCE
St.272
DETERMINE DWT ORDER N
St.273
n ← 0
St.274
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^n
St.275
DWT
DECOMPOSE INPUT DATA TO SCALING COEFFICIENTS AND WAVELET COEFFICIENTS
St.276
STORE SCALING COEFFICIENTS IN THE FIRST HALF OF DATA; STORE WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.277
n < N ?
YES
NO
St.278
QUANTIZE THE DATA
St.279
ROUND THE DATA
END

FIG. 19

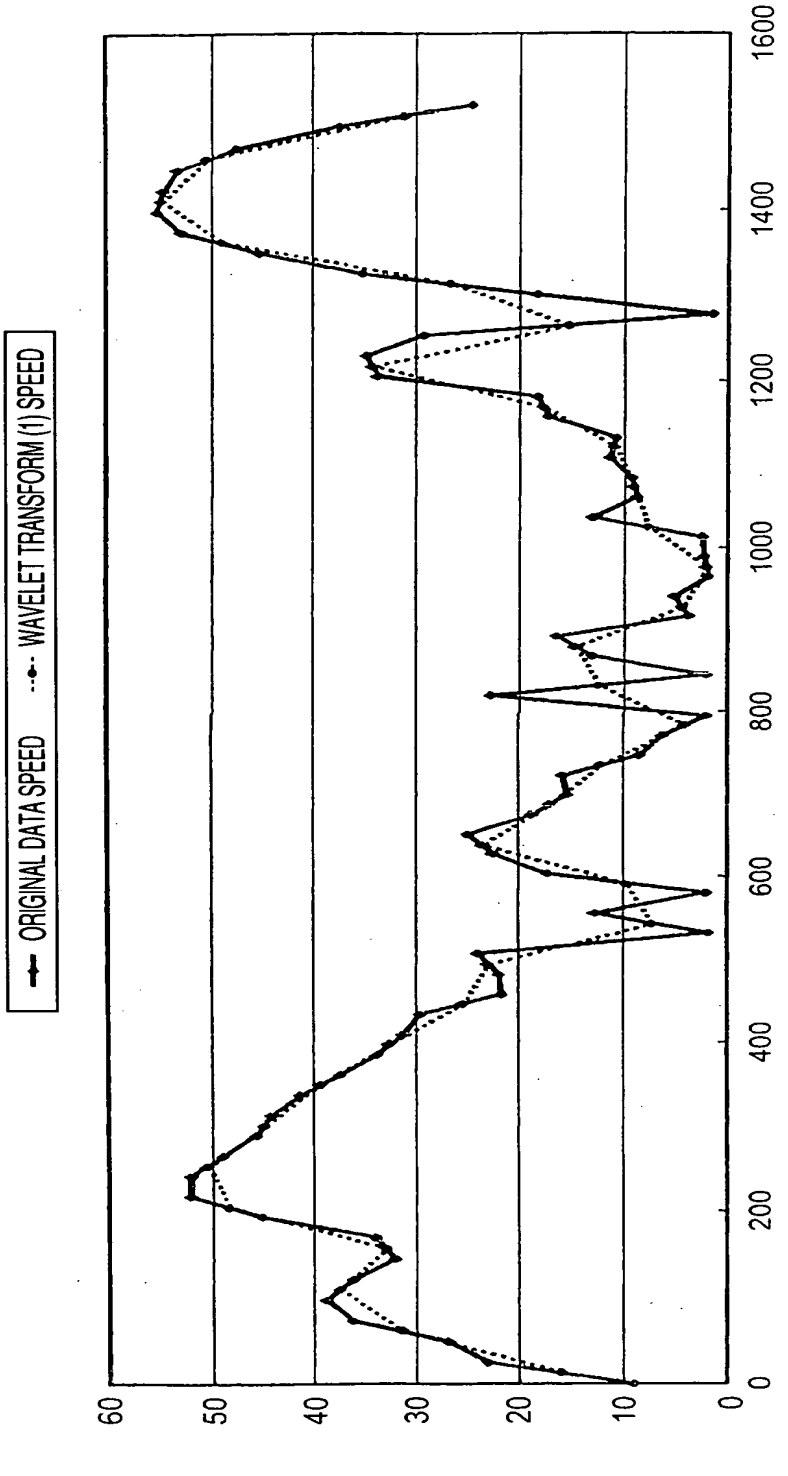

ORIGINAL DATA SPEED
WAVELET TRANSFORM (1) SPEED
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600

FIG. 20

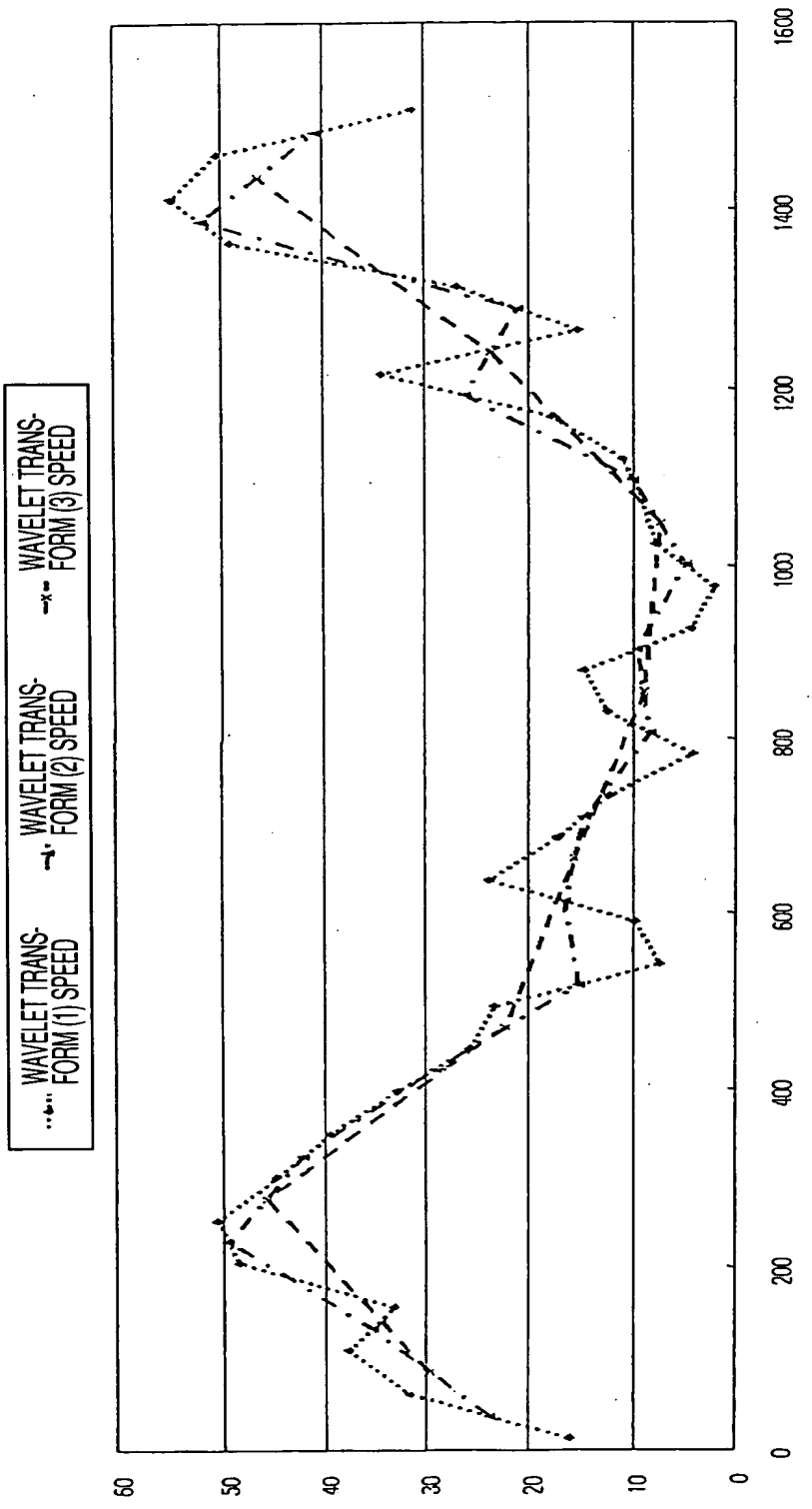

WAVELET TRANS-FORM (1) SPEED
WAVELET TRANS-FORM (2) SPEED
WAVELET TRANS-FORM (3) SPEED
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600

FIG. 21

(CONT.)

(a)

SAMPLING	CUMULATIVE DISTANCE	QUANTIZATION SAMPLE
0	0.00	1
1	24.11	1
2	48.22	1
3	72.33	1
4	96.44	1
5	120.56	1
6	144.67	1
7	168.78	1
8	192.89	1
9	217.00	1
10	241.11	1
11	265.22	1
12	289.33	1
13	313.44	1
14	337.56	1
15	361.67	1
16	385.78	1
17	409.89	1
18	434.00	1
19	458.11	1
20	482.22	1
21	506.33	1
22	530.44	1
23	554.56	1
24	578.67	1
25	602.78	1
26	626.89	1
27	651.00	1
28	675.11	1
29	699.22	1
30	723.33	1
31	747.44	1
32	771.56	1
33	795.67	1
34	819.78	1
35	843.89	1
36	868.00	1
37	892.11	1
38	916.22	1
39	940.33	1
40	964.44	1
41	988.56	1
42	1012.67	1
43	1036.78	1
44	1060.89	1
45	1085.00	1
46	1109.11	1
47	1133.22	1
48	1157.33	1
49	1181.44	1
50	1205.56	1
51	1229.67	1
52	1253.78	1
53	1277.89	1
54	1302.00	1
55	1326.11	1
56	1350.22	1
57	1374.33	1
58	1398.44	1
59	1422.56	1
60	1446.67	1
61	1470.78	1
62	1494.89	1
63	1519.00	1

(b)

ORIGINAL DATA	
SPEED	RANK
9	1
23	1
27	1
36	1
39	1
36	1
32	1
34	1
45	1
52	1
52	1
49	1
46	1
44	1
41	1
38	1
34	1
31	1
29	1
22	1
22	1
24	1
2	1
13	1
2	1
17	1
22	1
25	1
19	1
16	1
16	1
9	1
6	1
2	1
23	1
32	1
13	1
16	4
45	4
52	4
52	4
39	4
9	4
11	4
11	4
17	4
18	4
35	4
29	4
18	4
35	4
55	4
55	4
53	4
47	4
37	4
25	4

LEVEL SHIFT

SUBTRACT THE AVERAGE OF MAXIMUM VALUE/MINIMUM VALUE OF DATA TO CONVERGE DATA AROUND 0.

(c)

INFORMATION SHIFT	
SPEED-25	RANK-20
-16	-1
-2	-1
2	-1
11	-1
14	-1
11	-1
7	-1
9	-1
20	-1
27	-1
27	-1
24	-1
21	-1
19	-1
16	-1
13	-1
9	-1
6	-1
4	-1
-3	-1
-3	-1
-1	-1
-23	-1
-12	-1
-23	-1
-8	-1
-3	-1
0	-1
-6	-1
-9	-1
-9	-1
-16	-1
-19	-1
-23	-1
-2	-1
-23	-1
-12	-1
-9	-1
-21	2
-20	2
-23	2
-23	2
-23	2
-12	2
-16	2
-16	2
-14	2
-14	2
-8	2
-7	2
9	0
10	0
4	0
-24	0
-7	0
10	0
20	0
28	0
30	0
30	0
28	2
22	2
12	2
0	2

DWT ON ALL DATA

PERFORM FIRST-ORDER WAVELET TRANSFORM ON ALL DATA.

(d)

WAVELET TRANSFORM (1)	
SPEED-25	RANK-20
-12.72792206	-1.414213562
9.192388155	-1.414213562
17.67766953	-1.414213562
11.3137085	-1.414213562
33.23401872	-1.414213562
36.06244584	-1.414213562
28.28427125	-1.414213562
20.50809665	-1.414213562
10.60660172	-1.414213562
SCALING COEFFICIENT LOW-PASS FILTER	
-2.121320344	-1.414213562
-10.60660172	-1.414213562
-17.67766853	-1.414213562
-29.69848481	-1.414213562
-17.67766953	-1.414213562
-14.8492424	-1.414213562
-28.99137803	2.828427125
-32.52691193	2.828427125
-24.74873734	2.828427125
-22.627417	2.828427125
-19.79898987	0
-10.60660172	0
13.43502884	0
-14.14213562	0
2.121320044	0
33.9411255	0
42.42640687	1.414213562
35.35533906	2.828427125
8.485281374	2.828427125
-9.899494937	0
-6.363961031	0
2.121320344	0
-1.414213562	0
-4.949747468	0
2.121320344	0
1.414213562	0
2.121320344	0
2.121320344	0
4.949747468	0
-1.414213562	0
WAVELET EXPANSION COEFFICIENT HIGH-PASS FILTER	
2.323427125	0
14.8492424	0
-2.121320344	0
-0.707106781	0
-1.33227E-15	0
-7.778174593	0
0	0
8.88178E-16	0
-0.707106781	0
-0.707106781	0
19.79898987	0
-12.02081528	0
-5.656854249	0
-8.88178E-16	-1.414213562
4.242640687	0
8.485281374	0

(FIG. 21 CONTINUED)

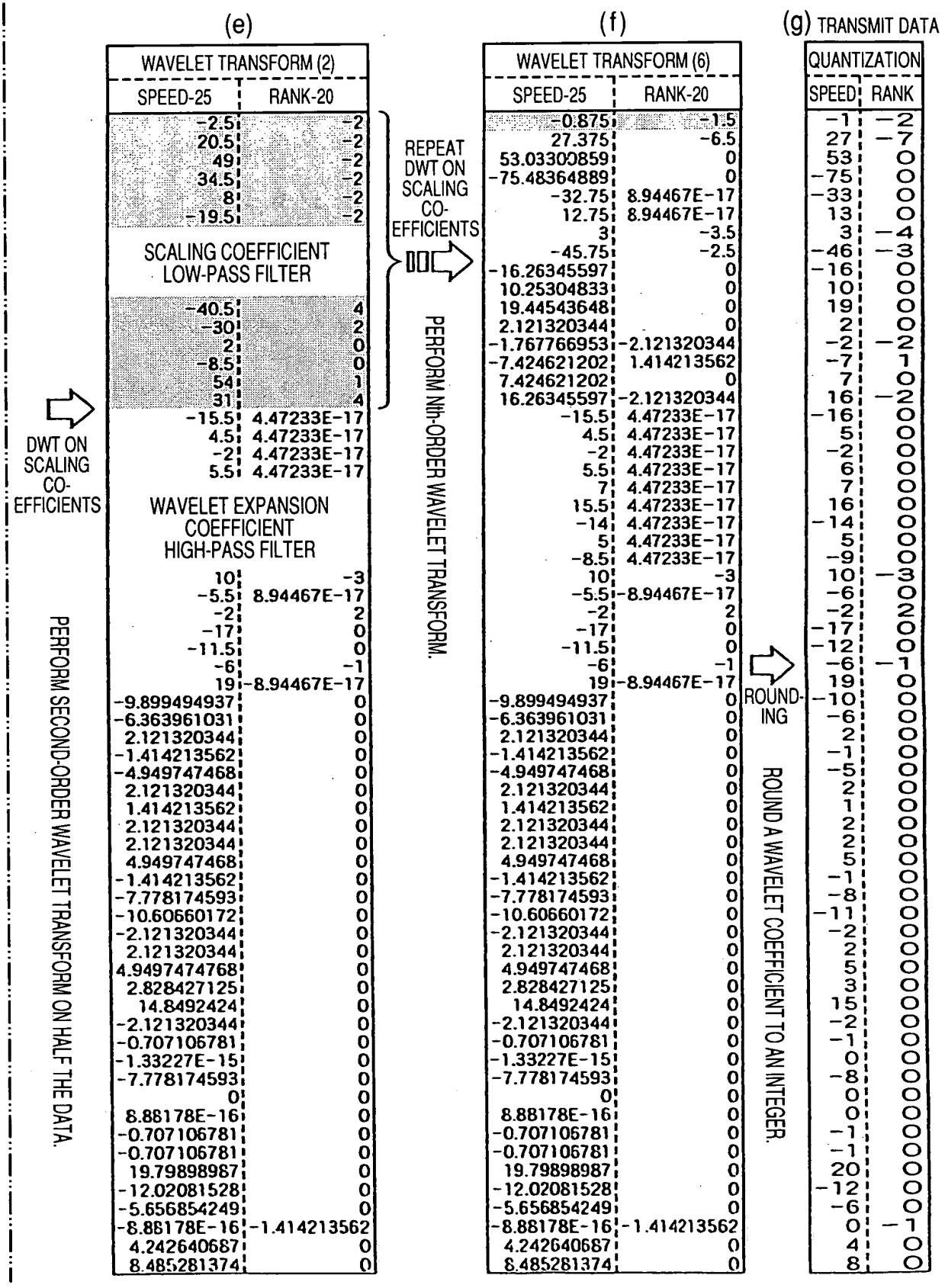


FIG. 22

(a) SHAPE VECTOR DATA STRING

SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
VECTOR DATA TYPE (= ROAD)
TOTAL NUMBER OF NODES
NODE NUMBER P_1
NODE 1X DIRECTION ABSOLUTE COORDINATE (LONGITUDE)
NODE 1Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE)
NODE 1 ABSOLUTE BEARING
≀
NODE NUMBER P_n
NODE N RELATIVE COORDINATE (X_n)
NODE N RELATIVE COORDINATE (Y_n)
NODE N RELATIVE BEARING
≀ ≀
SHAPE VECTOR STRING IDENTIFICATION NUMBER = 100
≀ ≀
SHAPE VECTOR STRING IDENTIFICATION NUMBER = ZZ
≀ ≀

(b) TRAFFIC INFORMATION DATA STRING

SCALING COEFFICIENT IDENTIFICATION FLAG
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DATA COUNT N_a
VALID DATA COUNT N_b
VALID BLOCK LENGTH | LEVEL SHIFT
FINAL ORDER OF DWT N
NTH-ORDER SCALING COEFFICIENT 1
≀
NTH-ORDER SCALING COEFFICIENT $N_a/2^N$
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 100
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = ZZ
≀ ≀

(c)

WAVELET COEFFICIENT IDENTIFICATION FLAG
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DWT ORDER N
NTH-ORDER WAVELET COEFFICIENT 1
≀
NTH-ORDER WAVELET COEFFICIENT $N_a/2^N$
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 100
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = ZZ
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DWT ORDER n
NTH-ORDER WAVELET COEFFICIENT 1
≀
NTH-ORDER WAVELET COEFFICIENT $N_a/2^n$
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = ZZ
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = Z
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DWT ORDER 1
FIRST-ORDER WAVELET COEFFICIENT 1
≀
FIRST-ORDER WAVELET COEFFICIENT $N_a/2$
≀ ≀

FIG. 23

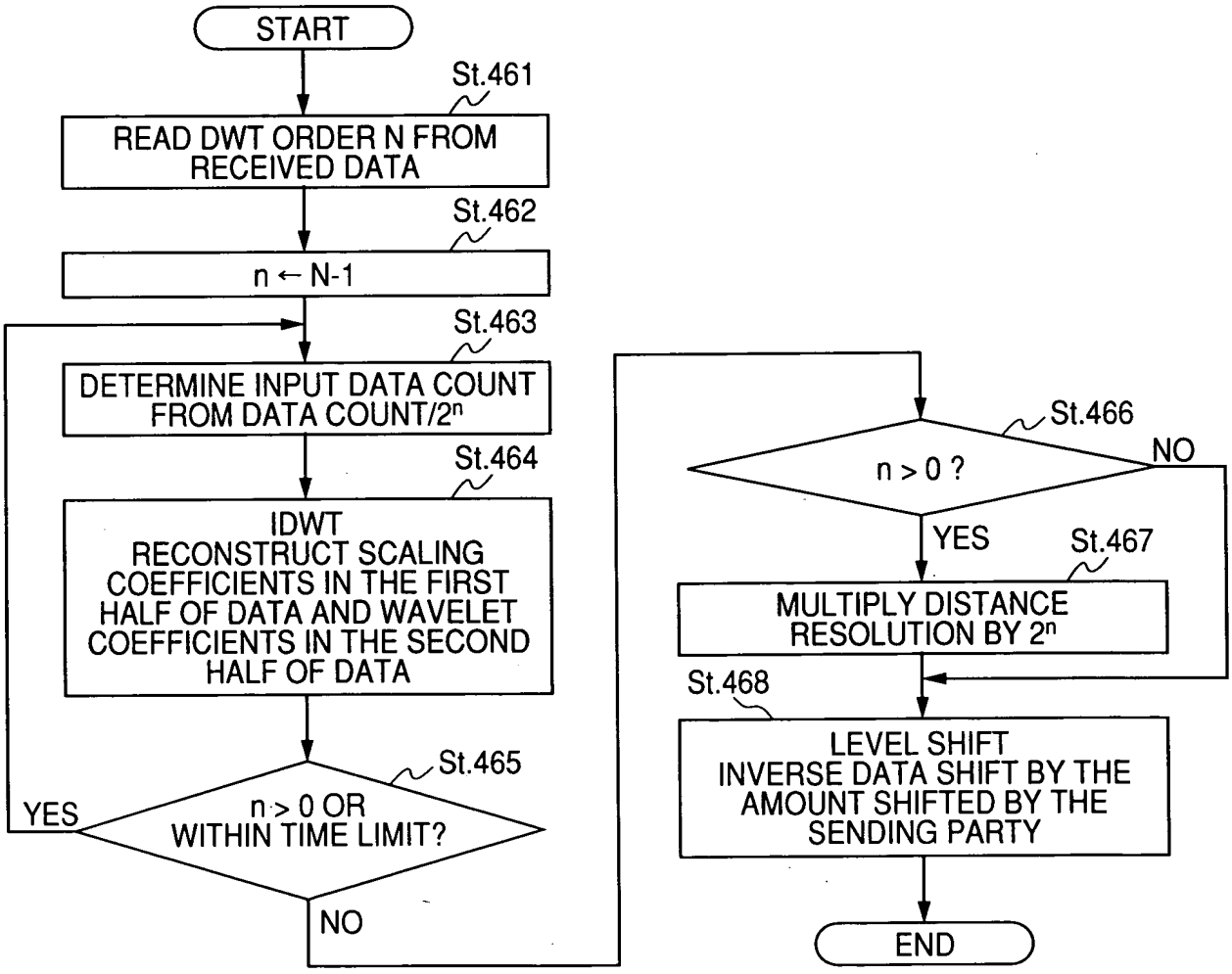

START
St.461
READ DWT ORDER N FROM RECEIVED DATA
St.462
n ← N-1
St.463
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^n
St.464
IDWT
RECONSTRUCT SCALING COEFFICIENTS IN THE FIRST HALF OF DATA AND WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.465
n > 0 OR WITHIN TIME LIMIT?
YES
NO
St.466
n > 0 ?
NO
YES
St.467
MULTIPLY DISTANCE RESOLUTION BY 2^n
St.468
LEVEL SHIFT
INVERSE DATA SHIFT BY THE AMOUNT SHIFTED BY THE SENDING PARTY
END

FIG. 24

(CONT.)

DATA RECEPTION

DEQUANTIZATION	
SPEED	RANK
−1	−2
27	−7
53	0
−75	0
−33	0
13	0
3	−4
−46	−3
−16	0
10	0
19	0
2	−2
−2	1
−7	0
7	−2
16	0
−16	0
5	0
−2	0
6	0
7	0
16	0
−14	0
5	0
−9	−3
10	0
−6	2
−2	0
−17	0
−12	−1
−6	0
19	0
−10	0
−6	0
2	0
−1	0
−5	0
2	0
1	0
2	0
2	0
5	0
−1	0
−8	0
−11	0
−2	0
2	0
5	0
3	0
15	0
−2	0
−1	0
0	0
−8	0
0	0
0	0
−1	0
−1	0
20	0
−12	0
−6	0
0	−1
4	0
8	0

Nth-ORDER INVERSE DWT

DETERMINE THE DATA COUNT FOR Nth-ORDER INVERSE DCT FROM THE DATA COUNT AND DWT RESOLUTION N.

INVERSE WAVELET TRANSFORM (6)	
SPEED-25	RANK-20
18.38477631	−8.363961031
−19.79898987	3.535533906
53	0
−75	0
−33	0
13	0
3	−4
−46	−3
−16	0
10	0
19	0
2	−2
−2	1
−7	0
7	−2
16	0
−16	0
5	0
−2	0
6	0
7	0
16	0
−14	0
5	0
−9	−3
10	0
−6	2
−2	0
−17	0
−12	−1
−6	0
19	0
−10	0
−6	0
2	0
−1	0
−5	0
2	0
1	0
2	0
2	0
5	0
−1	0
−8	0
−11	0
−2	0
2	0
5	0
3	0
15	0
−2	0
−1	0
0	0
−8	0
0	0
0	0
−1	0
−1	0
20	0
−12	0
−6	0
0	−1
4	0
8	0

(N-1)th-ORDER INVERSE DWT

DOUBLE THE CONVERSION RANGE AND PERFORM (N-1)th-ORDER INVERSE DWT.

INVERSE WAVELET TRANSFORM (5)	
SPEED-25	RANK-20
SCALING COEFFICIENT LOW-PASS FILTER	
WAVELET EXPANSION COEFFICIENT HIGH-PASS FILTER	
−16	0
10	0
19	0
2	0
−2	−2
−7	1
7	0
16	−2
−16	0
5	0
−2	0
6	0
7	0
16	0
−14	0
5	0
−9	0
10	−3
−6	0
−2	2
−17	0
−12	0
−6	−1
19	0
−10	0
−6	0
2	0
−1	0
−5	0
2	0
1	0
2	0
2	0
5	0
−1	0
−8	0
−11	0
−2	0
2	0
5	0
3	0
15	0
−2	0
−1	0
0	0
−8	0
0	0
0	0
−1	0
−1	0
20	0
−12	0
−6	0
0	−1
4	0
8	0

(FIG. 24 CONTINUED)

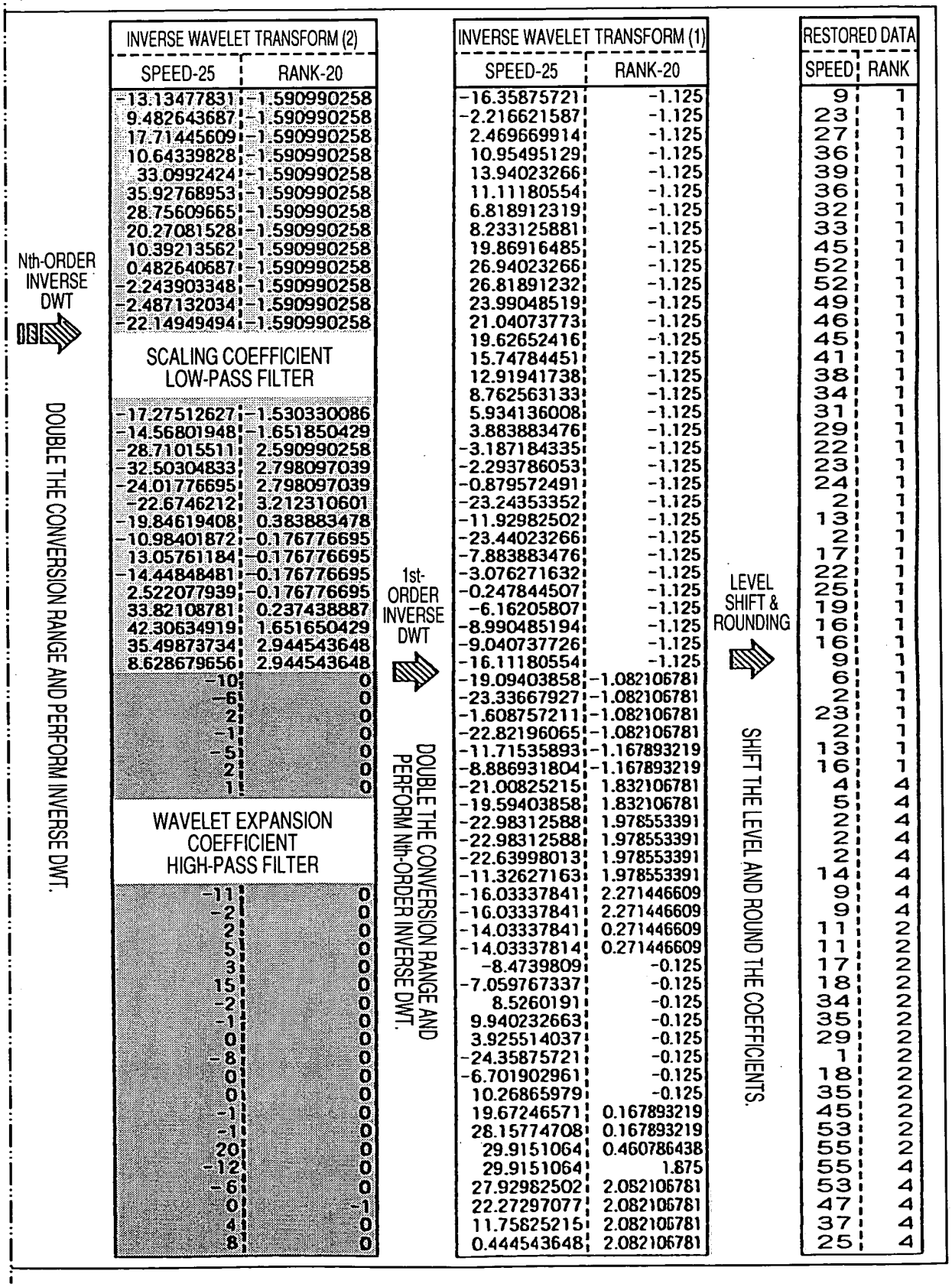


FIG. 25(a)

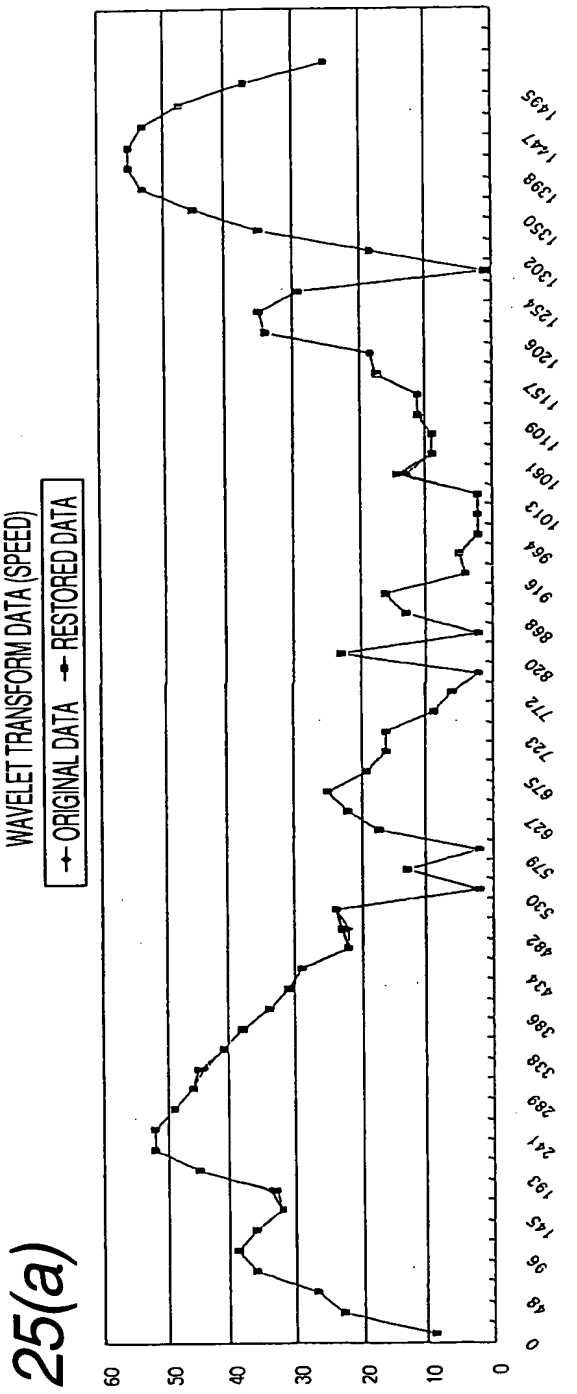


FIG. 25(b)

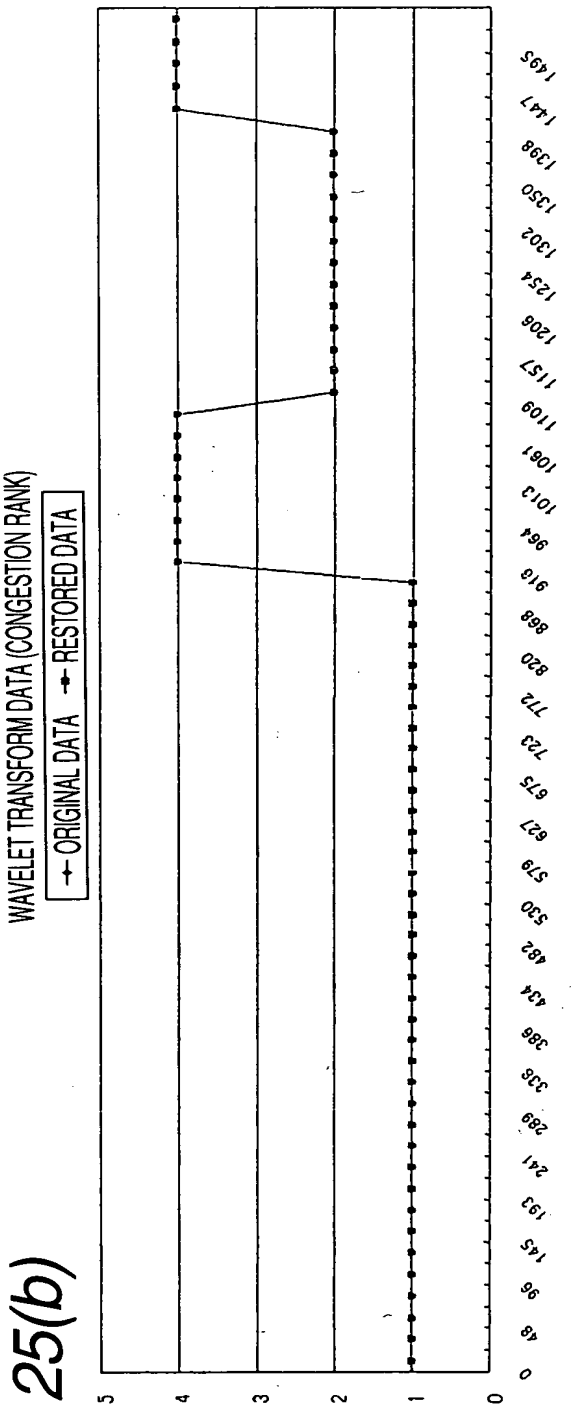


FIG. 26

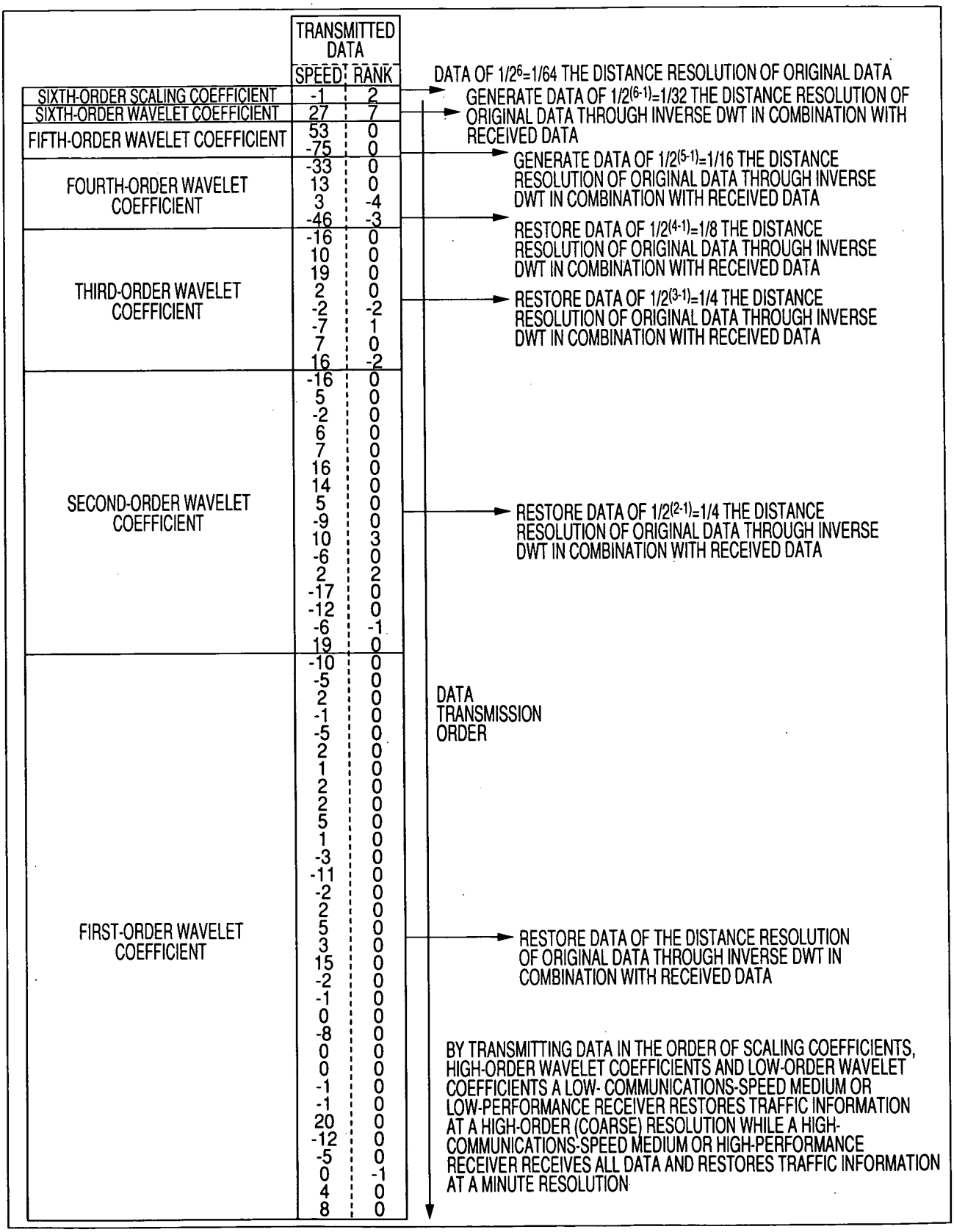

TRANSMITTED DATA
SPEED
RANK
SIXTH-ORDER SCALING COEFFICIENT
SIXTH-ORDER WAVELET COEFFICIENT
FIFTH-ORDER WAVELET COEFFICIENT
FOURTH-ORDER WAVELET COEFFICIENT
THIRD-ORDER WAVELET COEFFICIENT
SECOND-ORDER WAVELET COEFFICIENT
FIRST-ORDER WAVELET COEFFICIENT
-1 2
27 7
53 0
-75 0
-33 0
13 0
3 -4
-46 -3
-16 0
10 0
19 0
2 0
-2 -2
-7 1
7 0
16 -2
-16 0
5 0
-2 0
6 0
7 0
16 0
14 0
5 0
-9 0
10 3
-6 0
2 2
-17 0
-12 0
-6 -1
19 0
-10 0
-5 0
2 0
-1 0
-5 0
2 0
1 0
2 0
2 0
5 0
1 0
-3 0
-11 0
-2 0
2 0
5 0
3 0
15 0
-2 0
-1 0
0 0
-8 0
0 0
0 0
-1 0
-1 0
20 0
-12 0
-5 0
0 -1
4 0
8 0
DATA OF 1/2^6=1/64 THE DISTANCE RESOLUTION OF ORIGINAL DATA
GENERATE DATA OF 1/2^(6-1)=1/32 THE DISTANCE RESOLUTION OF ORIGINAL DATA THROUGH INVERSE DWT IN COMBINATION WITH RECEIVED DATA
GENERATE DATA OF 1/2^(5-1)=1/16 THE DISTANCE RESOLUTION OF ORIGINAL DATA THROUGH INVERSE DWT IN COMBINATION WITH RECEIVED DATA
RESTORE DATA OF 1/2^(4-1)=1/8 THE DISTANCE RESOLUTION OF ORIGINAL DATA THROUGH INVERSE DWT IN COMBINATION WITH RECEIVED DATA
RESTORE DATA OF 1/2^(3-1)=1/4 THE DISTANCE RESOLUTION OF ORIGINAL DATA THROUGH INVERSE DWT IN COMBINATION WITH RECEIVED DATA
RESTORE DATA OF 1/2^(2-1)=1/4 THE DISTANCE RESOLUTION OF ORIGINAL DATA THROUGH INVERSE DWT IN COMBINATION WITH RECEIVED DATA
DATA TRANSMISSION ORDER
RESTORE DATA OF THE DISTANCE RESOLUTION OF ORIGINAL DATA THROUGH INVERSE DWT IN COMBINATION WITH RECEIVED DATA
BY TRANSMITTING DATA IN THE ORDER OF SCALING COEFFICIENTS, HIGH-ORDER WAVELET COEFFICIENTS AND LOW-ORDER WAVELET COEFFICIENTS A LOW- COMMUNICATIONS-SPEED MEDIUM OR LOW-PERFORMANCE RECEIVER RESTORES TRAFFIC INFORMATION AT A HIGH-ORDER (COARSE) RESOLUTION WHILE A HIGH-COMMUNICATIONS-SPEED MEDIUM OR HIGH-PERFORMANCE RECEIVER RECEIVES ALL DATA AND RESTORES TRAFFIC INFORMATION AT A MINUTE RESOLUTION

FIG. 27

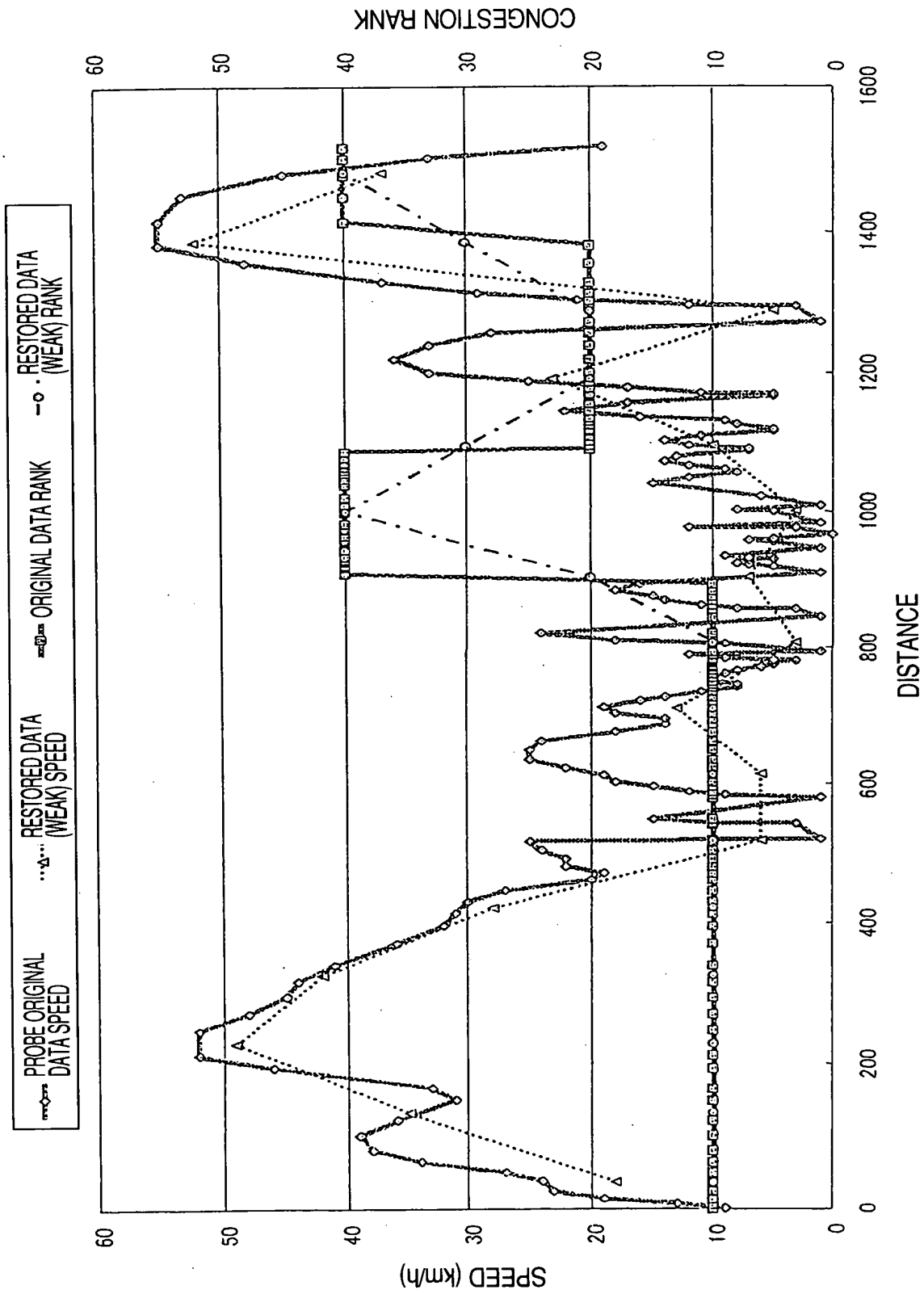

PROBE ORIGINAL DATA SPEED
RESTORED DATA (WEAK) SPEED
ORIGINAL DATA RANK
RESTORED DATA (WEAK) RANK
SPEED (km/h)
CONGESTION RANK
DISTANCE
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
1600

FIG. 28

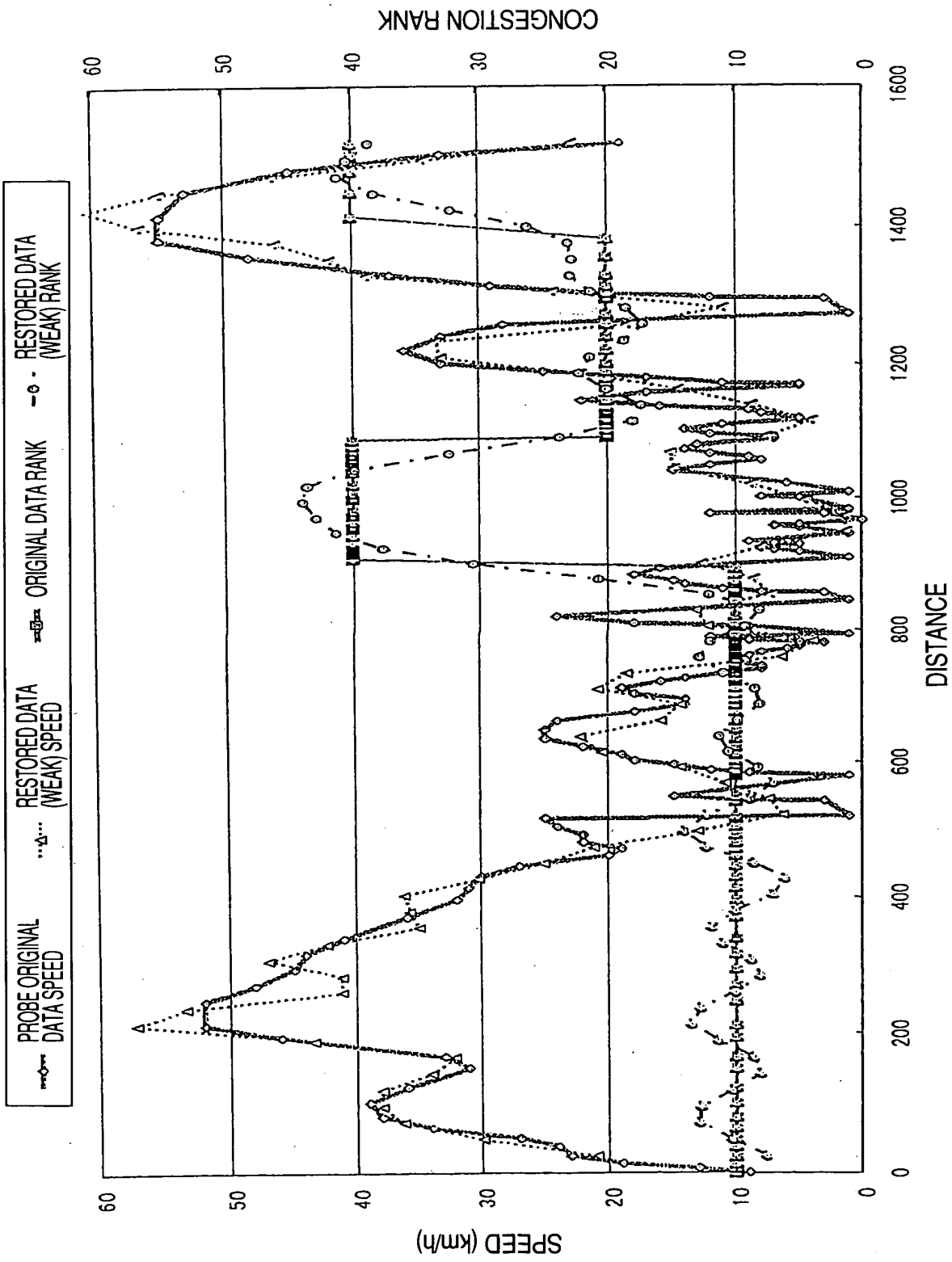

PROBE ORIGINAL DATA SPEED
RESTORED DATA (WEAK) SPEED
ORIGINAL DATA RANK
RESTORED DATA (WEAK) RANK
SPEED (km/h)
CONGESTION RANK
DISTANCE
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
1600

FIG. 29(a)

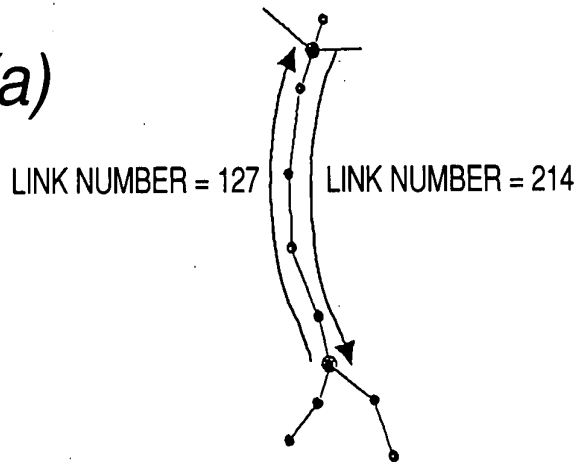


FIG. 29(b)

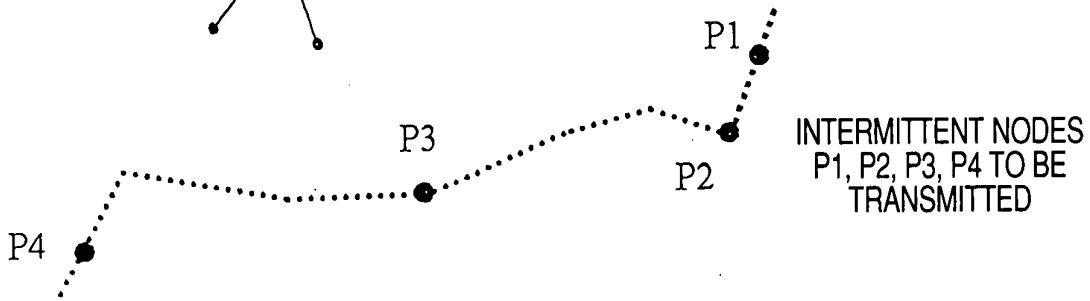


FIG. 29(c)

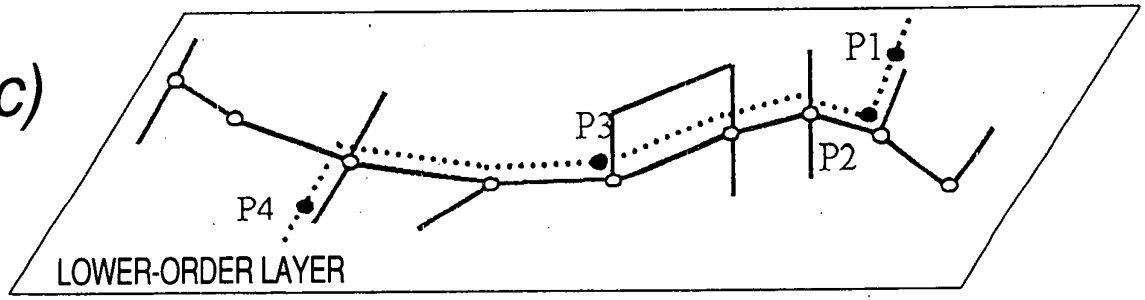
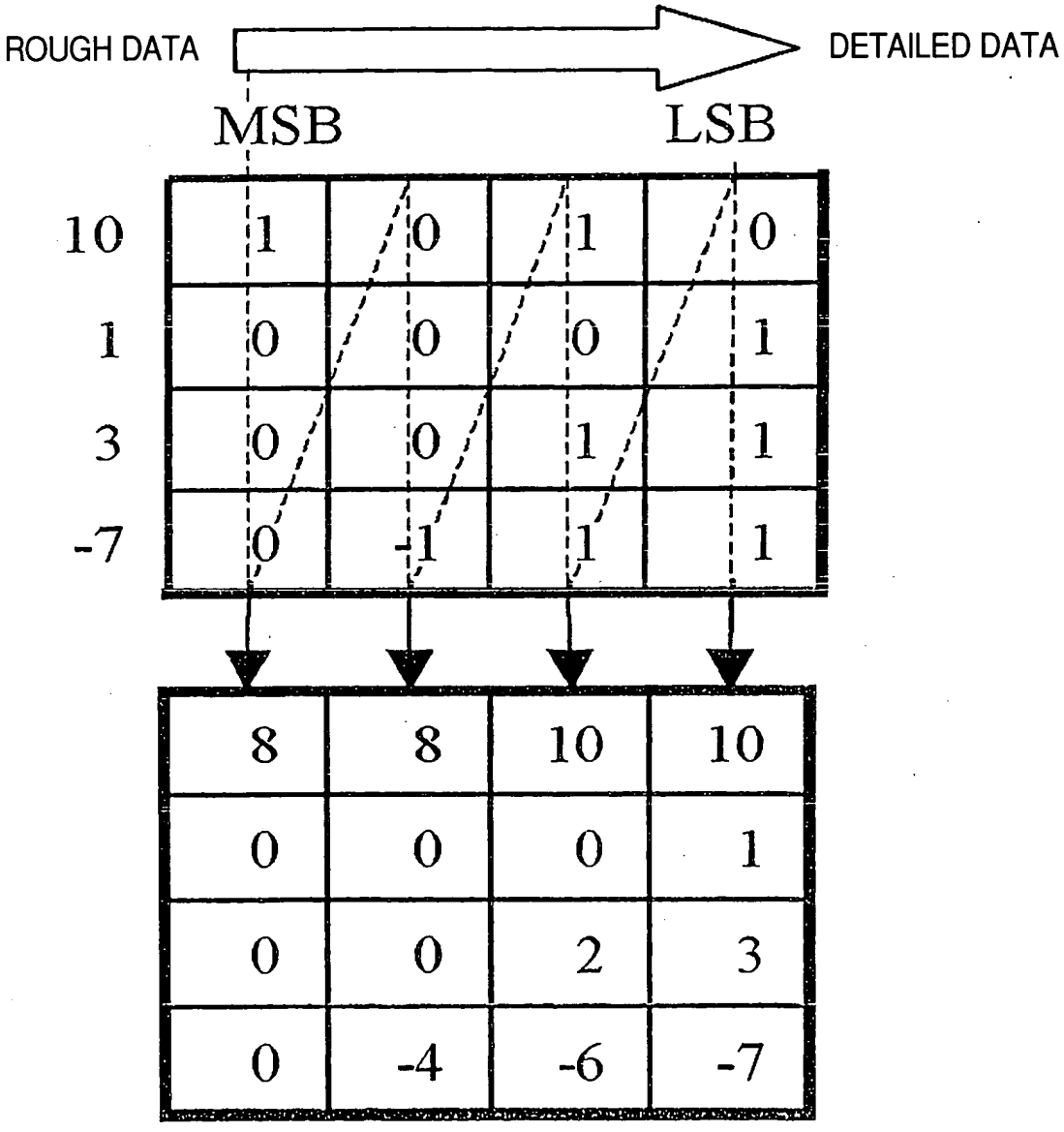


FIG. 30



DATA OBTAINED FROM TRANSMITTED INFORMATION

FIG. 31

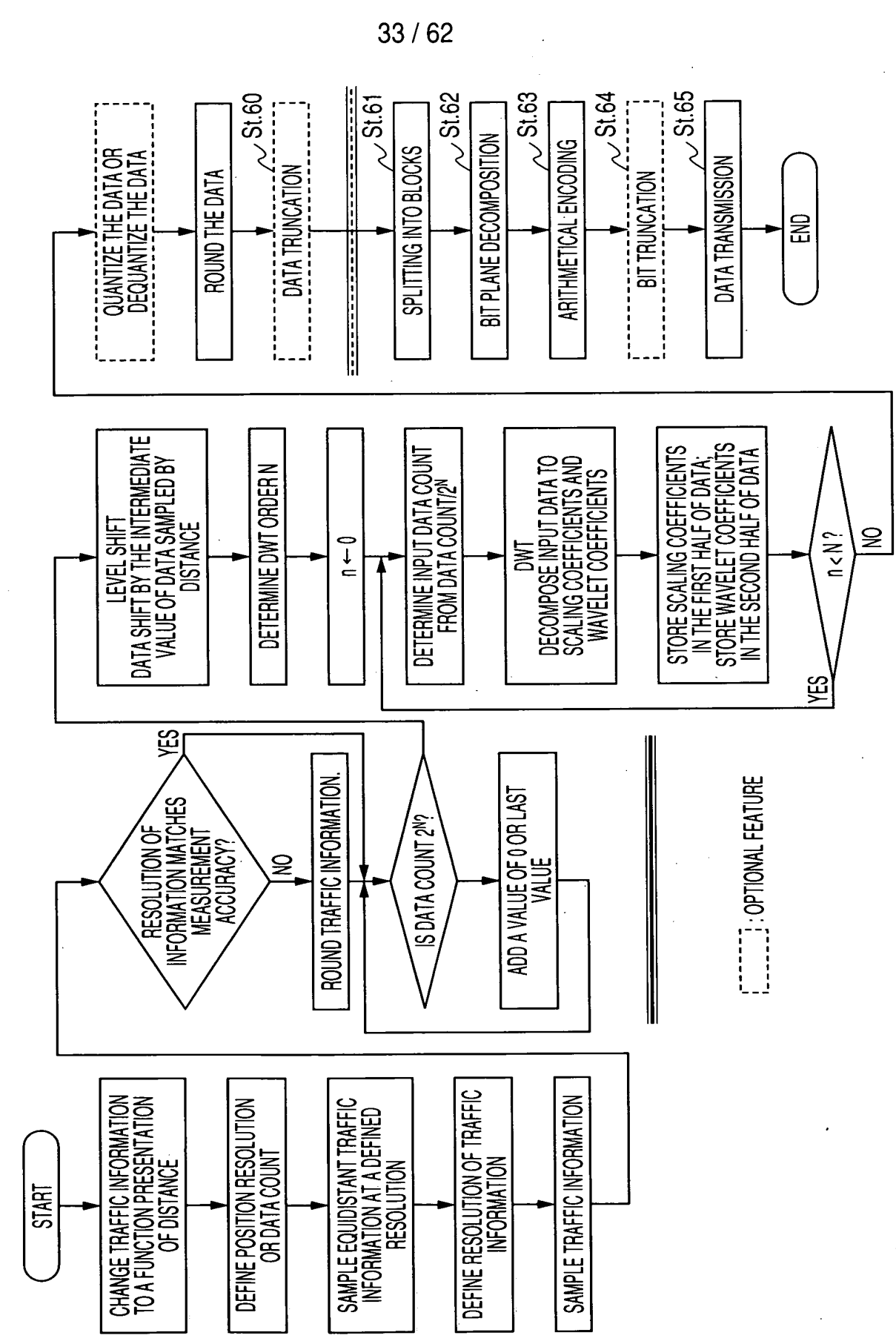
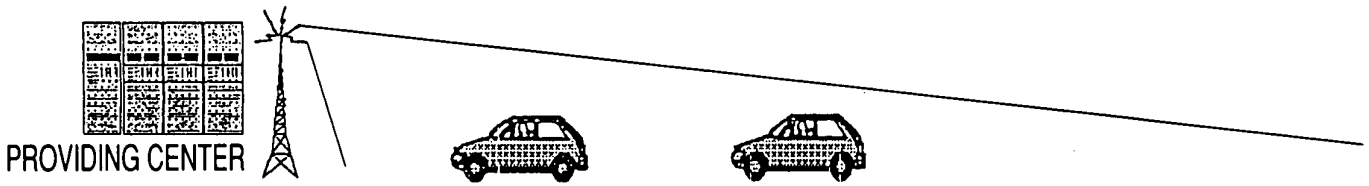

START
CHANGE TRAFFIC INFORMATION TO A FUNCTION PRESENTATION OF DISTANCE
DEFINE POSITION RESOLUTION OR DATA COUNT
SAMPLE EQUIDISTANT TRAFFIC INFORMATION AT A DEFINED RESOLUTION
DEFINE RESOLUTION OF TRAFFIC INFORMATION
SAMPLE TRAFFIC INFORMATION
RESOLUTION OF INFORMATION MATCHES MEASUREMENT ACCURACY?
YES
NO
ROUND TRAFFIC INFORMATION.
IS DATA COUNT 2^N?
ADD A VALUE OF 0 OR LAST VALUE
LEVEL SHIFT
DATA SHIFT BY THE INTERMEDIATE VALUE OF DATA SAMPLED BY DISTANCE
DETERMINE DWT ORDER N
n ← 0
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^N
DWT
DECOMPOSE INPUT DATA TO SCALING COEFFICIENTS AND WAVELET COEFFICIENTS
STORE SCALING COEFFICIENTS IN THE FIRST HALF OF DATA; STORE WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
n < N?
YES
NO
QUANTIZE THE DATA OR DEQUANTIZE THE DATA
ROUND THE DATA
St.60
DATA TRUNCATION
St.61
SPLITTING INTO BLOCKS
St.62
BIT PLANE DECOMPOSITION
St.63
ARITHMETICAL ENCODING
St.64
BIT TRUNCATION
St.65
DATA TRANSMISSION
END
: OPTIONAL FEATURE

FIG. 32



		SECRET KEY OF ENCRYPTION		
		ILLEGAL COPY	GENERAL MEMBER	SPECIAL MEMBER
NTH-ORDER SCALING COEFFICIENT	APPEND COPYRIGHT INFORMATION TO LOW-ORDER BITS	TRAFFIC INFORMATION IS CORRUPTED IN CASE DATA IS RESTORED WITHOUT DELETING THE COPYRIGHT INFORMATION	DELETE THE COPYRIGHT INFORMATION AND RESTORE THE TRAFFIC INFORMATION. CORRECT RESTORATION IS ALLOWED	
NTH-ORDER WAVELET COEFFICIENT	APPEND COPYRIGHT INFORMATION TO LOW-ORDER BITS			
(N-1)TH-ORDER WAVELET COEFFICIENT	APPEND COPYRIGHT INFORMATION TO LOW-ORDER BITS			
⋮				
SECOND-ORDER WAVELET COEFFICIENT	ENCRYPT HIGH-ORDER BITS	×	○	○
FIRST-ORDER WAVELET COEFFICIENT	ENCRYPT HIGH-ORDER BITS	×	×	○ (CAN REFER TO MORE DETAILED INFORMATION THAN A GENERAL MEMBER)

FIG. 33

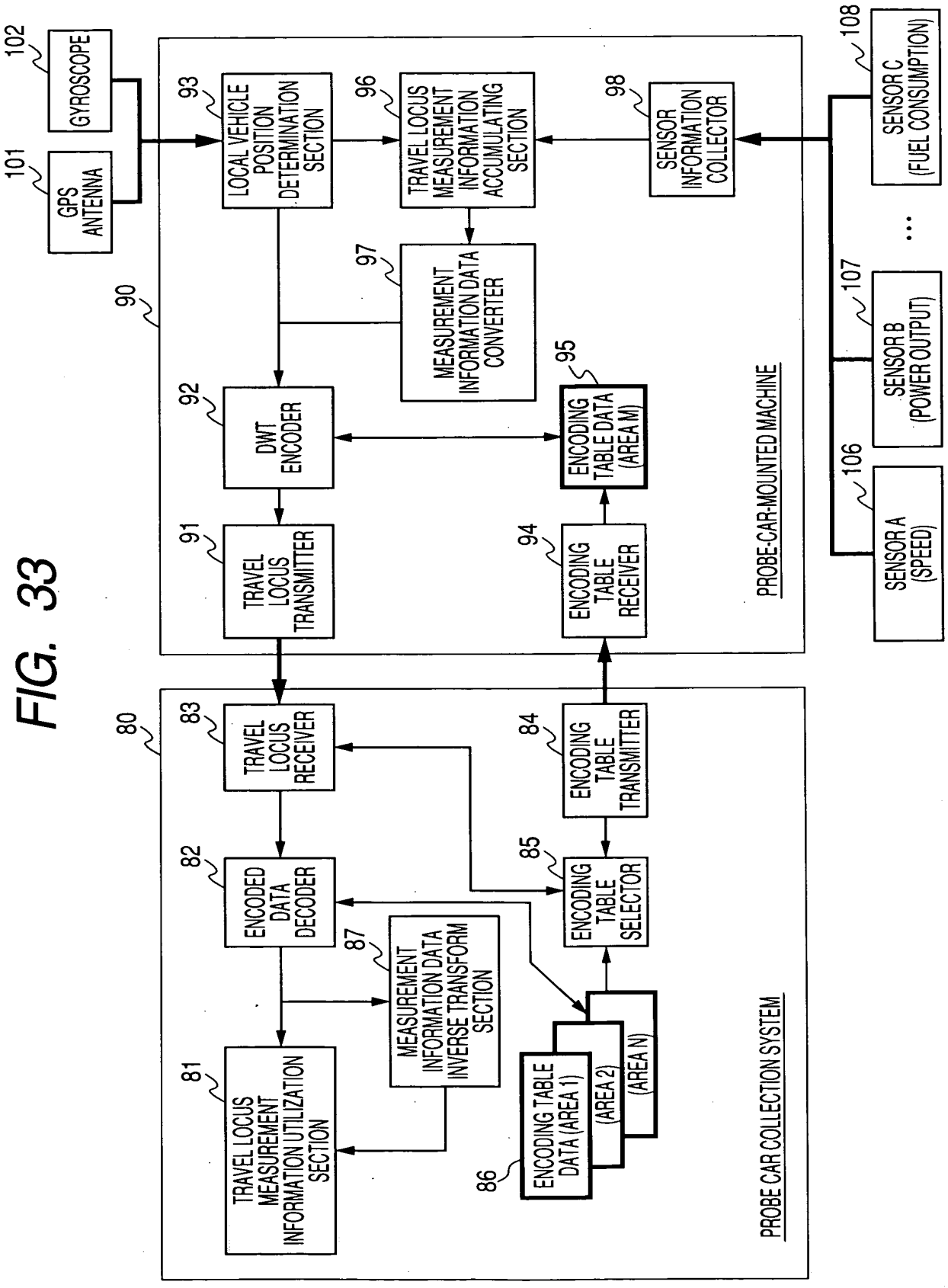

102
GYROSCOPE
101
GPS ANTENNA
93
LOCAL VEHICLE POSITION DETERMINATION SECTION
96
TRAVEL LOCUS MEASUREMENT INFORMATION ACCUMULATING SECTION
98
SENSOR INFORMATION COLLECTOR
108
SENSOR C (FUEL CONSUMPTION)
107
SENSOR B (POWER OUTPUT)
106
SENSOR A (SPEED)
90
97
MEASUREMENT INFORMATION DATA CONVERTER
92
DWT ENCODER
95
ENCODING TABLE DATA (AREA M)
91
TRAVEL LOCUS TRANSMITTER
94
ENCODING TABLE RECEIVER
PROBE-CAR-MOUNTED MACHINE
80
83
TRAVEL LOCUS RECEIVER
84
ENCODING TABLE TRANSMITTER
82
ENCODED DATA DECODER
85
ENCODING TABLE SELECTOR
87
MEASUREMENT INFORMATION DATA INVERSE TRANSFORM SECTION
81
TRAVEL LOCUS MEASUREMENT INFORMATION UTILIZATION SECTION
86
ENCODING TABLE DATA (AREA 1)
(AREA 2)
(AREA N)
PROBE CAR COLLECTION SYSTEM

FIG. 34

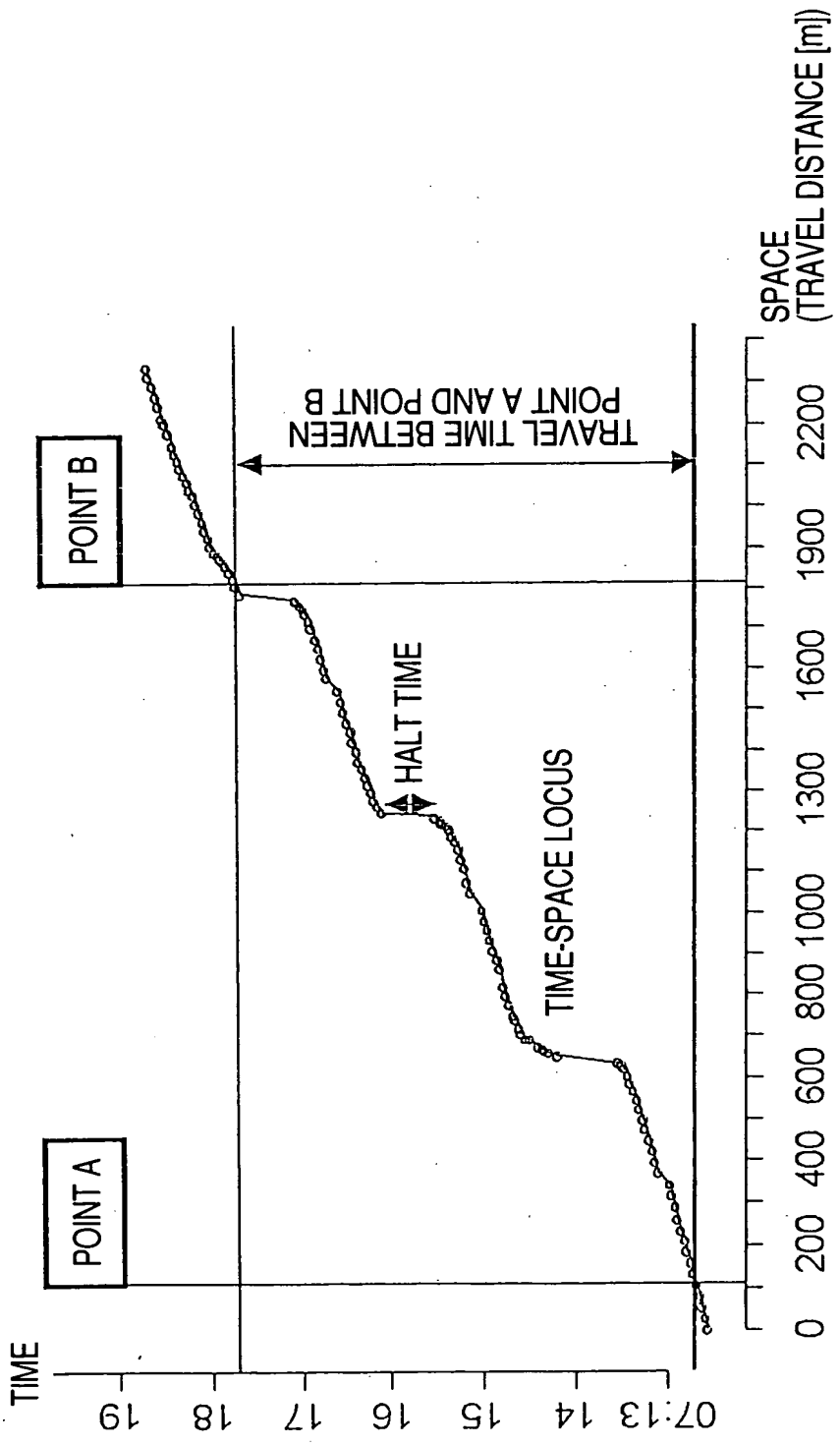

TIME
19
18
17
16
15
14
07:13
POINT A
POINT B
TRAVEL TIME BETWEEN POINT A AND POINT B
HALT TIME
TIME-SPACE LOCUS
SPACE (TRAVEL DISTANCE [m])
0
200
400
600
800
1000
1300
1600
1900
2200

FIG. 35

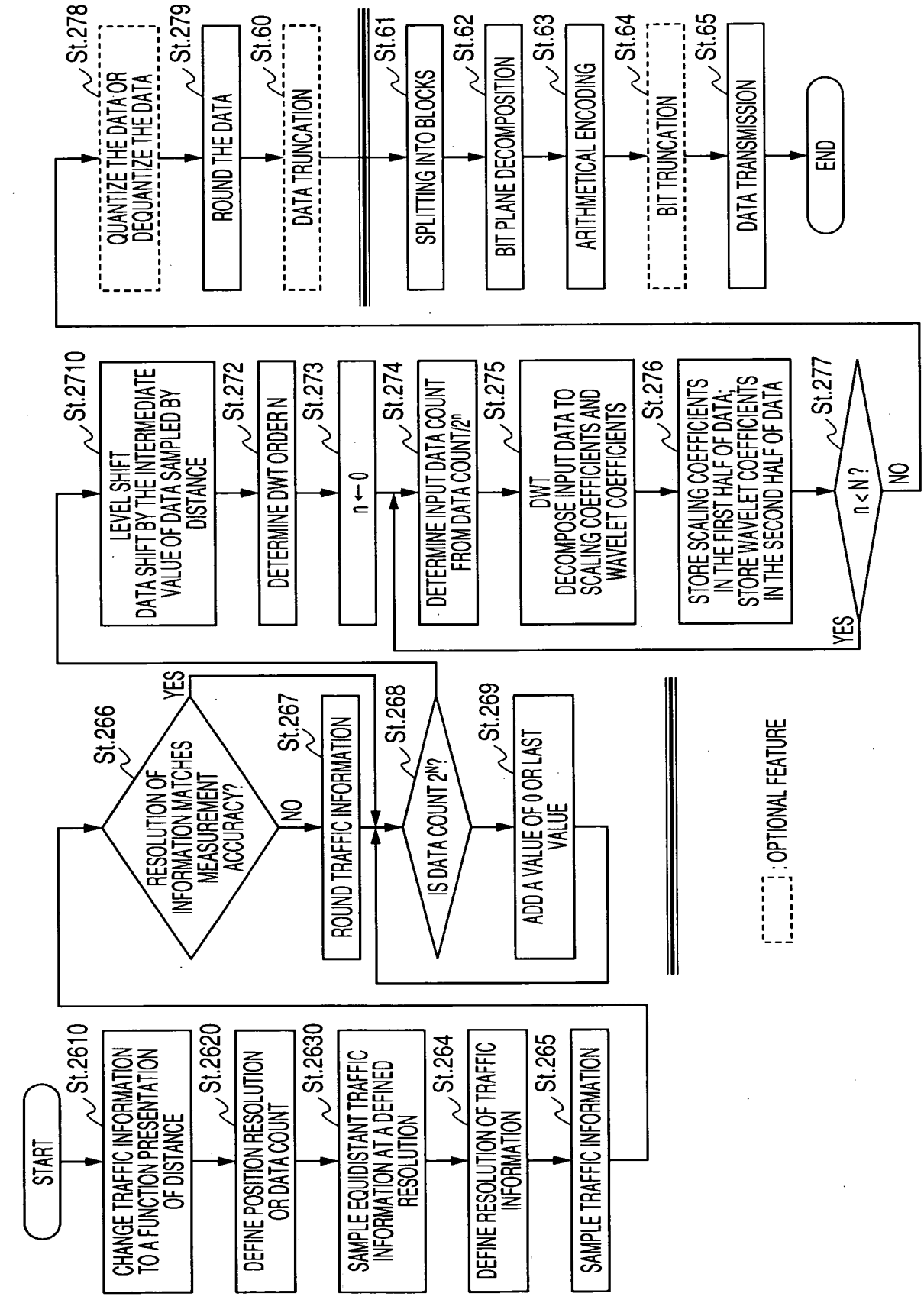

START
St.2610
CHANGE TRAFFIC INFORMATION TO A FUNCTION PRESENTATION OF DISTANCE
St.2620
DEFINE POSITION RESOLUTION OR DATA COUNT
St.2630
SAMPLE EQUIDISTANT TRAFFIC INFORMATION AT A DEFINED RESOLUTION
St.264
DEFINE RESOLUTION OF TRAFFIC INFORMATION
St.265
SAMPLE TRAFFIC INFORMATION
St.266
RESOLUTION OF INFORMATION MATCHES MEASUREMENT ACCURACY?
YES
NO
St.267
ROUND TRAFFIC INFORMATION
St.268
IS DATA COUNT 2^N?
St.269
ADD A VALUE OF 0 OR LAST VALUE
St.2710
LEVEL SHIFT DATA SHIFT BY THE INTERMEDIATE VALUE OF DATA SAMPLED BY DISTANCE
St.272
DETERMINE DWT ORDER N
St.273
n ← 0
St.274
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^n
St.275
DWT DECOMPOSE INPUT DATA TO SCALING COEFFICIENTS AND WAVELET COEFFICIENTS
St.276
STORE SCALING COEFFICIENTS IN THE FIRST HALF OF DATA; STORE WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.277
n < N ?
YES
NO
St.278
QUANTIZE THE DATA OR DEQUANTIZE THE DATA
St.279
ROUND THE DATA
St.60
DATA TRUNCATION
St.61
SPLITTING INTO BLOCKS
St.62
BIT PLANE DECOMPOSITION
St.63
ARITHMETICAL ENCODING
St.64
BIT TRUNCATION
St.65
DATA TRANSMISSION
END
: OPTIONAL FEATURE

FIG. 36

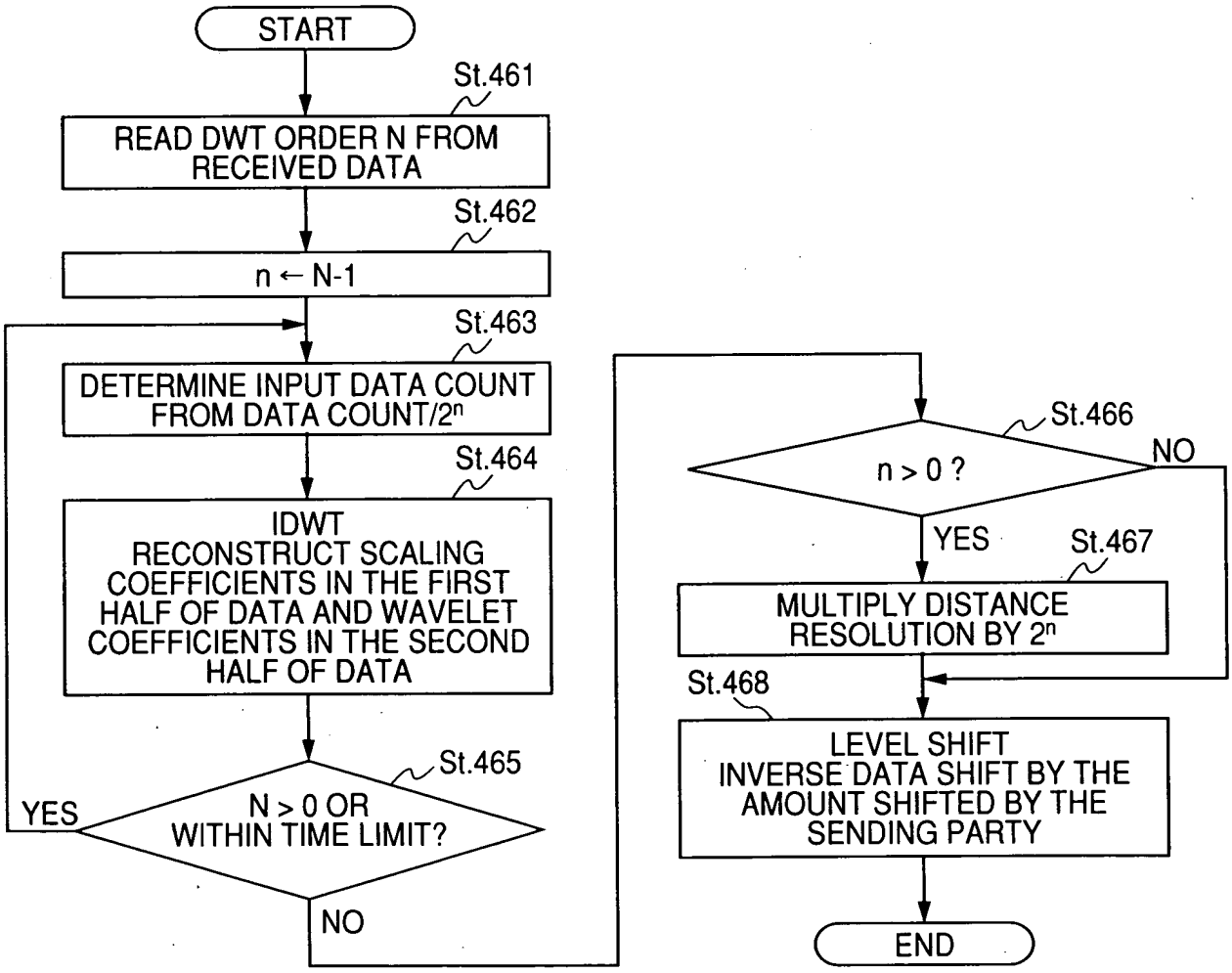

START
St.461
READ DWT ORDER N FROM RECEIVED DATA
St.462
n ← N-1
St.463
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^n
St.464
IDWT RECONSTRUCT SCALING COEFFICIENTS IN THE FIRST HALF OF DATA AND WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.465
N > 0 OR WITHIN TIME LIMIT?
YES
NO
St.466
n > 0 ?
NO
YES
St.467
MULTIPLY DISTANCE RESOLUTION BY 2^n
St.468
LEVEL SHIFT INVERSE DATA SHIFT BY THE AMOUNT SHIFTED BY THE SENDING PARTY
END

FIG. 37

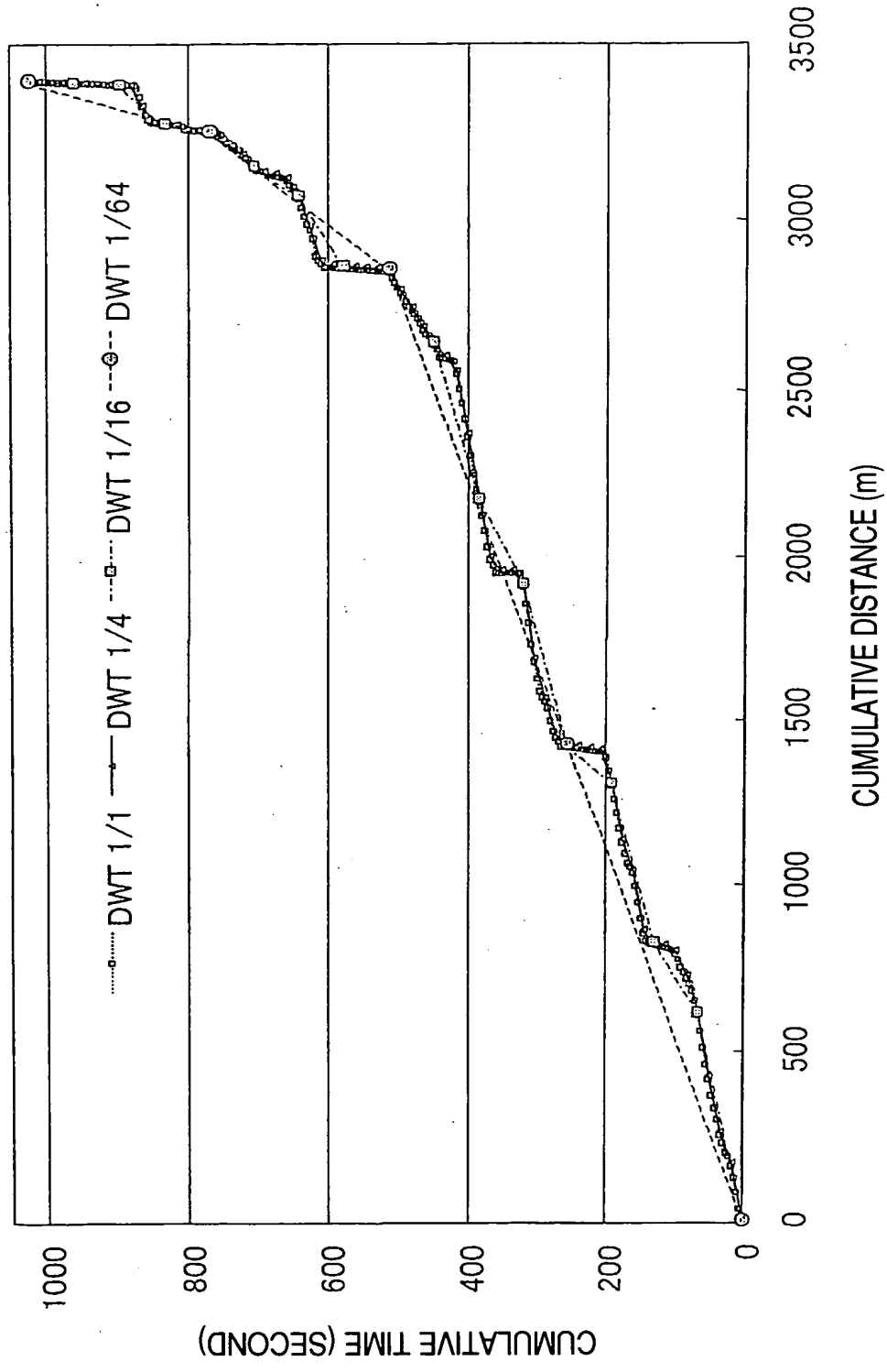

TRAVEL LOCUS
DWT 1/1
DWT 1/4
DWT 1/16
DWT 1/64
CUMULATIVE TIME (SECOND)
0
200
400
600
800
1000
CUMULATIVE DISTANCE (m)
0
500
1000
1500
2000
2500
3000
3500

FIG. 38

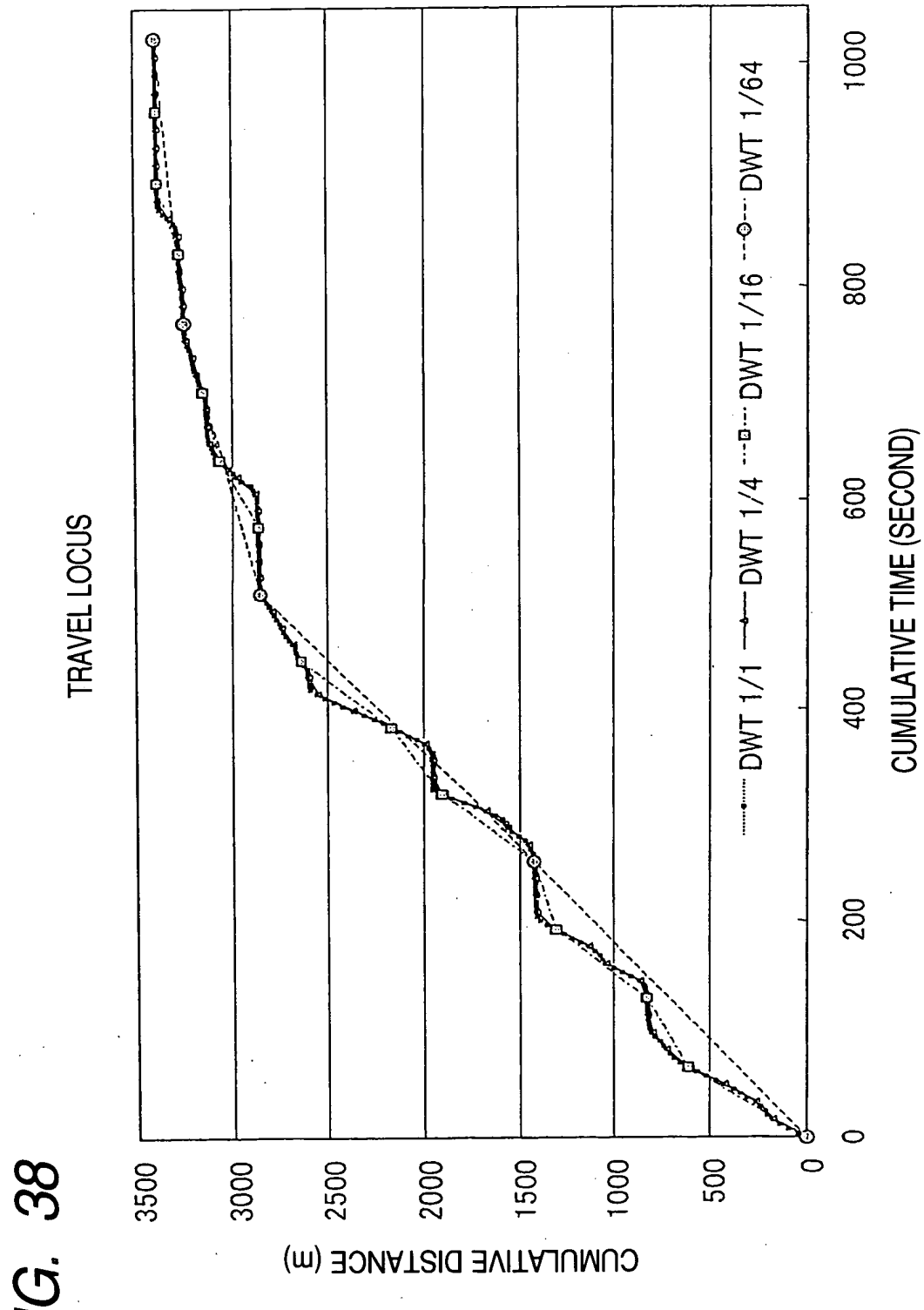

TRAVEL LOCUS
CUMULATIVE DISTANCE (m)
3500
3000
2500
2000
1500
1000
500
0
0
200
400
600
800
1000
CUMULATIVE TIME (SECOND)
DWT 1/1
DWT 1/4
DWT 1/16
DWT 1/64

FIG. 39

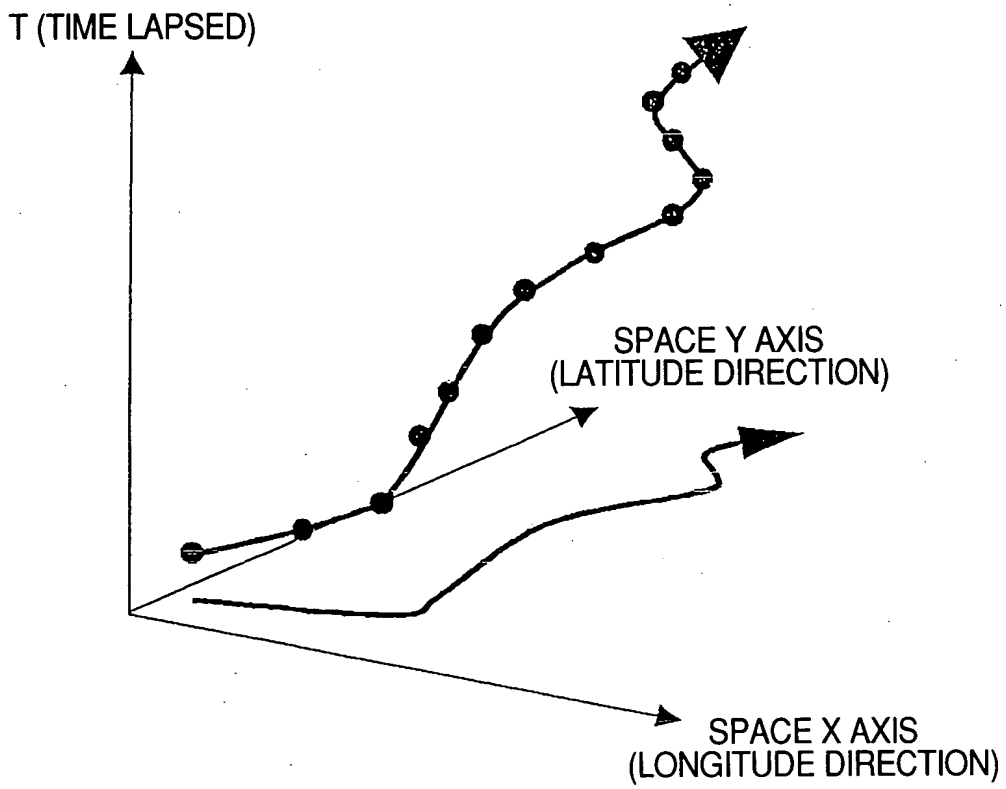

T (TIME LAPSED)
SPACE Y AXIS
(LATITUDE DIRECTION)
SPACE X AXIS
(LONGITUDE DIRECTION)

FIG. 40

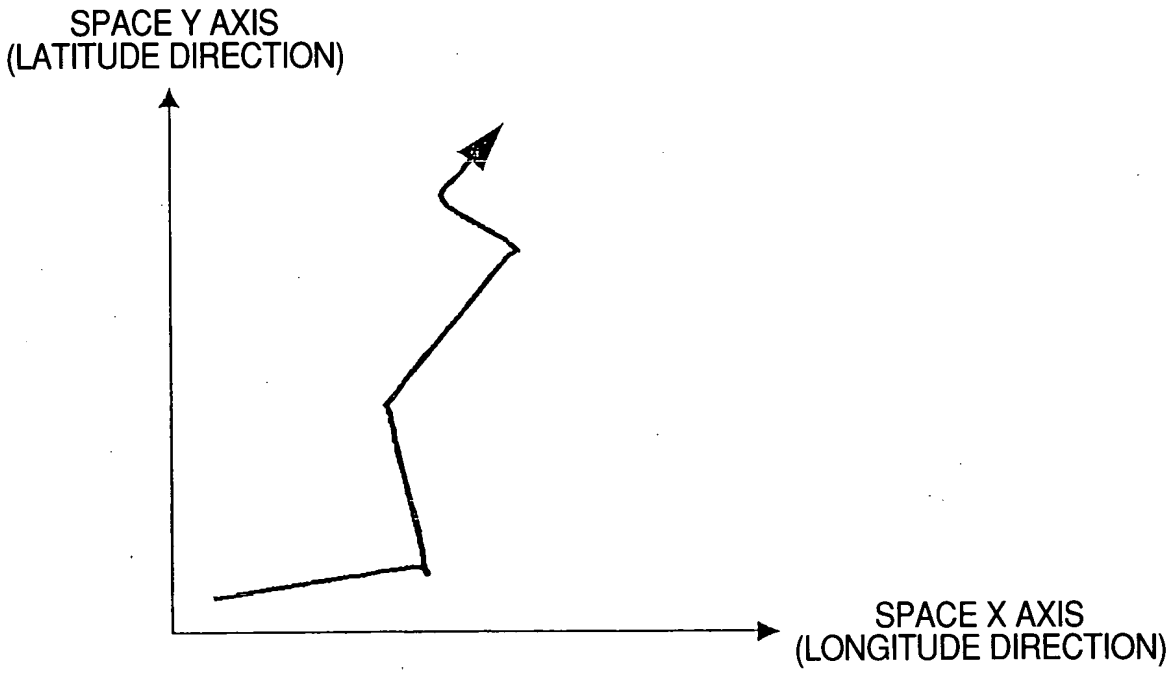

SPACE Y AXIS
(LATITUDE DIRECTION)
SPACE X AXIS
(LONGITUDE DIRECTION)

FIG. 41(a)

SHAPE VECTOR REFERENCE NODE

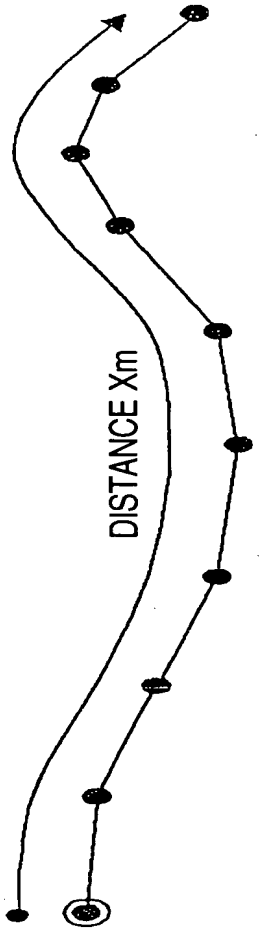


FIG. 41(b)

QUANTIZATION OF SAMPLING POINTS IN DISTANCE DIRECTION

FIG. 42

(a)

SHAPE VECTOR DATA STRING INFORMATION
(ENCODED/COMPRESSED DATA)

HEADER INFORMATION	
NO. OF SHAPE VECTORS N	
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1	
ENCODING TABLE IDENTIFICATION CODE	
ACCURACY INFORMATION OF MAP DATA AT SHAPE SOURCE	
DIRECTION OF ONE-WAY TRAFFIC (FORWARD/BACKWARD/NONE)	
BEGINNING NODE NUMBER ps	
NODE ps X DIRECTION ABSOLUTE COORDINATE (LONGITUDE)	
NODE ps Y DIRECTION ABSOLUTE COORDINATE (LATITUDE)	
NODE ps ABSOLUTE BEARING	
ps POSITION ERROR (m)	ps BEARING ERROR (°)
MAXIMUM POSITION ERROR OF ENCODED SHAPE DATA (m)	MAXIMUM POSITION ERROR OF ENCODED SHAPE DATA (°)
ENCODED SHAPE DATA INCLUDES THE FOLLOWING INFORMATION: - REFERENCE NODE SETTING CODE - SECTION LENGTH CHANGE CODE -EOD CODE	
END NODE NUMBER pe	
NODE pe X DIRECTION RELATIVE COORDINATE (LONGITUDE)	
NODE pe Y DIRECTION RELATIVE COORDINATE (LATITUDE)	
NODE pe ABSOLUTE BEARING	
pe POSITION ERROR (m)	pe BEARING ERROR (°)
≀	
SHAPE VECTOR DATA IDENTIFICATION NUMBER = M	
≀	

(b)

EXAMPLE OF TRAFFIC INFORMATION
REPRESENTED BY FFT

HEADER INFORMATION	
NO. OF TRAFFIC-INFORMATION-PROVIDED SECTIONS V	
TRAFFIC-INFORMATION-PROVIDED SECTION SERIAL NUMBER 1	
REFERENCE SHAPE VECTOR STRING NUMBER = N	
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)	
BEGINNING REFERENCE NODE Pa	END REFERENCE NODE Pb
TRAFFIC INFORMATION QUANTIZATION TABLE IDENTIFICATION CODE	
ENCODING TABLE IDENTIFICATION CODE	
AMOUNT OF SECTION SPLITTING BETWEEN REFERENCE NODES 2^N	
DATA STRING WHERE FOURIER COEFFICIENTS ARE VARIABLE LENGTH ENCODED IN THE ORDER OF REAL PART TO IMAGINARY PART, AND LOW FREQUENCIES TO HIGH FREQUENCIES	
≀	
TRAFFIC-INFORMATION-PROVIDED SECTION SERIAL NUMBER = W	
≀	

FIG. 43

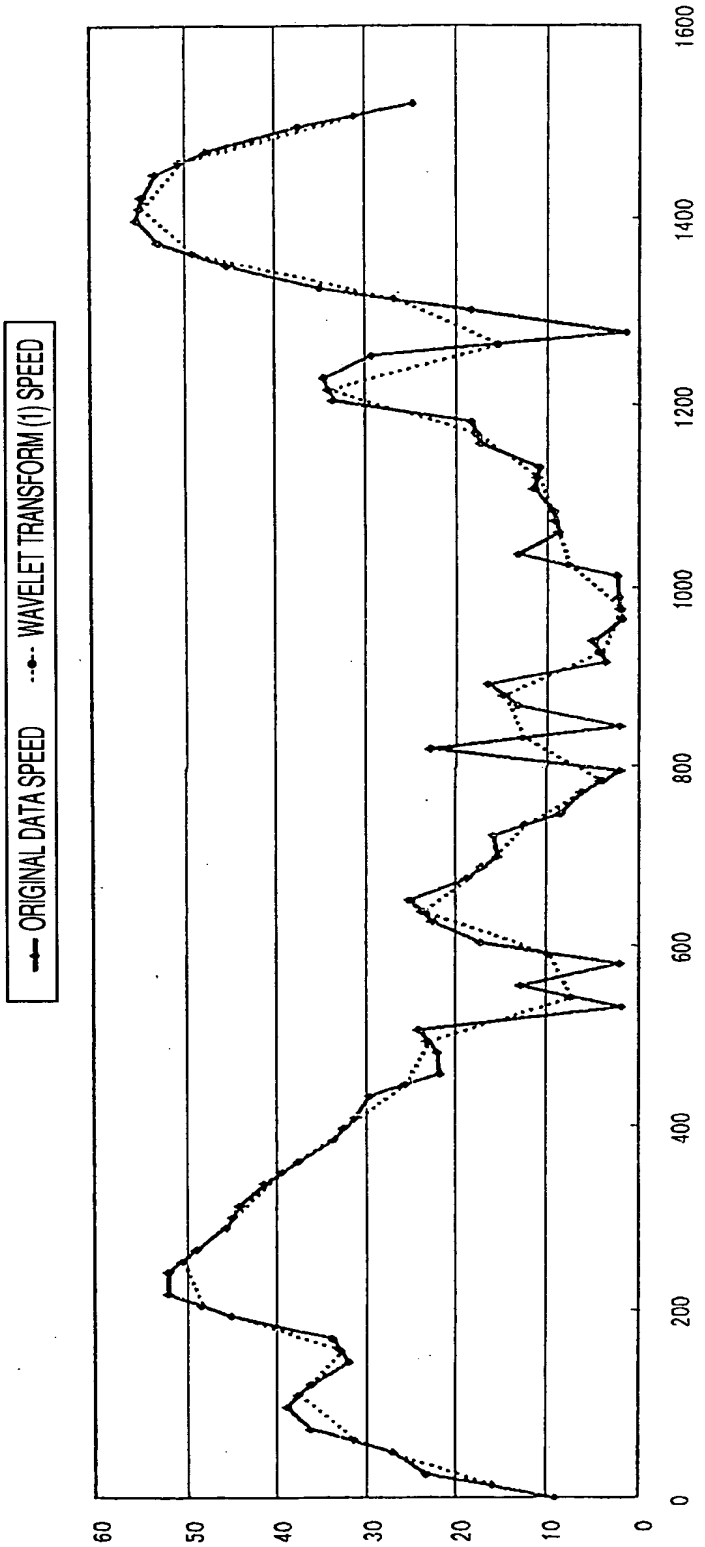

ORIGINAL DATA SPEED
WAVELET TRANSFORM (1) SPEED
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600

FIG. 44

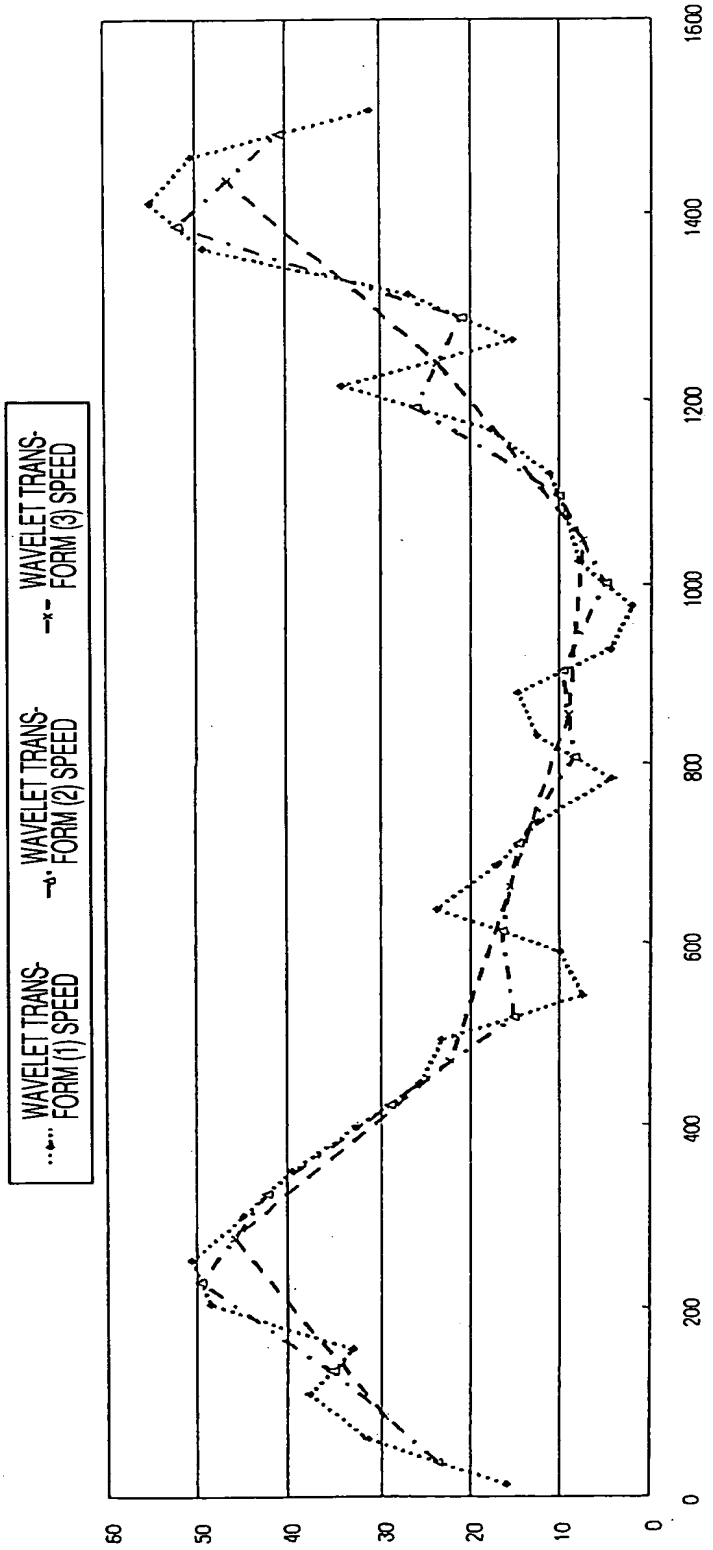

WAVELET TRANSFORM (1) SPEED
WAVELET TRANSFORM (2) SPEED
WAVELET TRANSFORM (3) SPEED
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600

FIG. 45

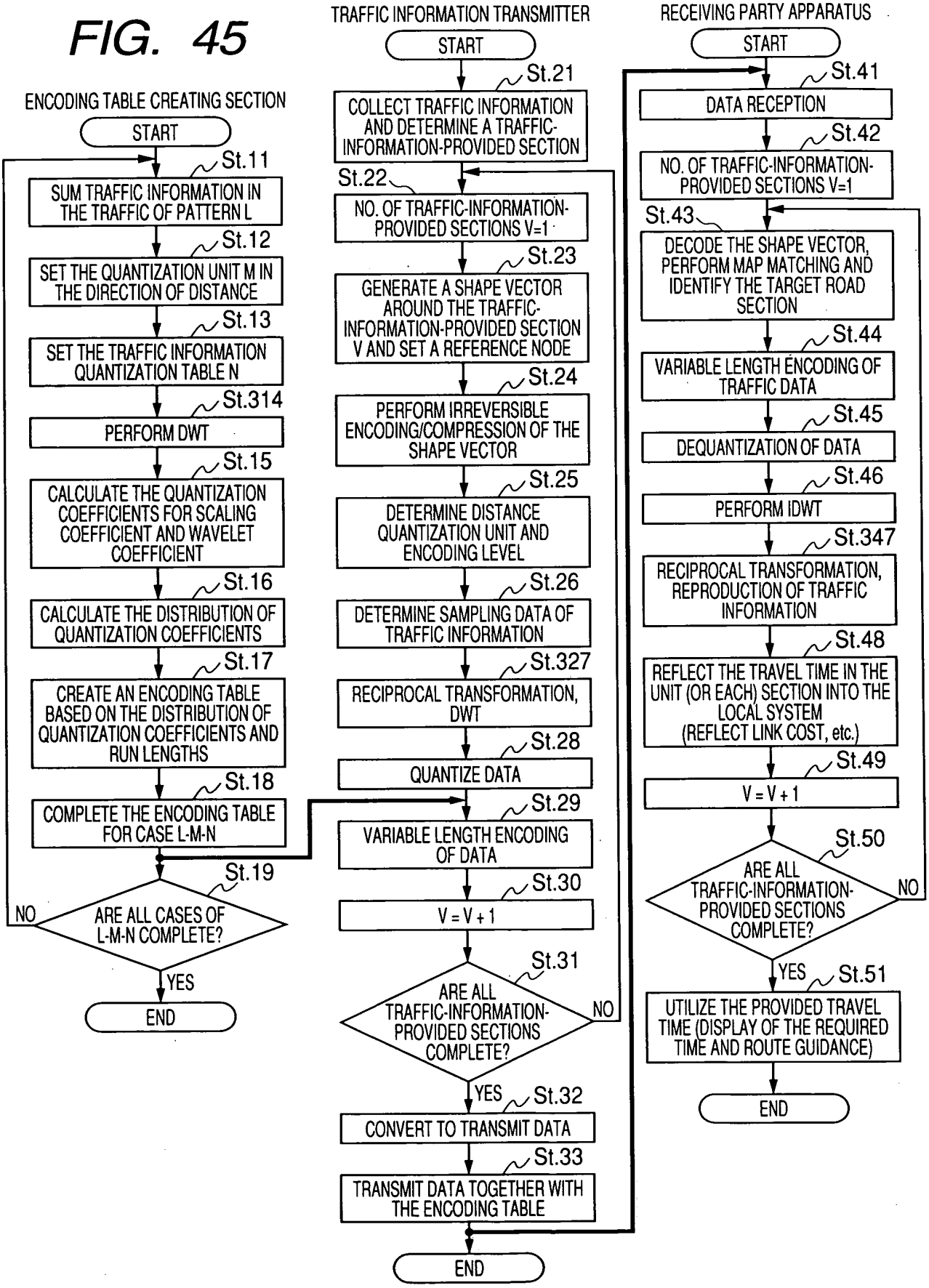

ENCODING TABLE CREATING SECTION
START
St.11
SUM TRAFFIC INFORMATION IN THE TRAFFIC OF PATTERN L
St.12
SET THE QUANTIZATION UNIT M IN THE DIRECTION OF DISTANCE
St.13
SET THE TRAFFIC INFORMATION QUANTIZATION TABLE N
St.314
PERFORM DWT
St.15
CALCULATE THE QUANTIZATION COEFFICIENTS FOR SCALING COEFFICIENT AND WAVELET COEFFICIENT
St.16
CALCULATE THE DISTRIBUTION OF QUANTIZATION COEFFICIENTS
St.17
CREATE AN ENCODING TABLE BASED ON THE DISTRIBUTION OF QUANTIZATION COEFFICIENTS AND RUN LENGTHS
St.18
COMPLETE THE ENCODING TABLE FOR CASE L-M-N
St.19
ARE ALL CASES OF L-M-N COMPLETE?
NO
YES
END
TRAFFIC INFORMATION TRANSMITTER
START
St.21
COLLECT TRAFFIC INFORMATION AND DETERMINE A TRAFFIC-INFORMATION-PROVIDED SECTION
St.22
NO. OF TRAFFIC-INFORMATION-PROVIDED SECTIONS V=1
St.23
GENERATE A SHAPE VECTOR AROUND THE TRAFFIC-INFORMATION-PROVIDED SECTION V AND SET A REFERENCE NODE
St.24
PERFORM IRREVERSIBLE ENCODING/COMPRESSION OF THE SHAPE VECTOR
St.25
DETERMINE DISTANCE QUANTIZATION UNIT AND ENCODING LEVEL
St.26
DETERMINE SAMPLING DATA OF TRAFFIC INFORMATION
St.327
RECIPROCAL TRANSFORMATION, DWT
St.28
QUANTIZE DATA
St.29
VARIABLE LENGTH ENCODING OF DATA
St.30
V = V + 1
St.31
ARE ALL TRAFFIC-INFORMATION-PROVIDED SECTIONS COMPLETE?
NO
YES
St.32
CONVERT TO TRANSMIT DATA
St.33
TRANSMIT DATA TOGETHER WITH THE ENCODING TABLE
END
RECEIVING PARTY APPARATUS
START
St.41
DATA RECEPTION
St.42
NO. OF TRAFFIC-INFORMATION-PROVIDED SECTIONS V=1
St.43
DECODE THE SHAPE VECTOR, PERFORM MAP MATCHING AND IDENTIFY THE TARGET ROAD SECTION
St.44
VARIABLE LENGTH ENCODING OF TRAFFIC DATA
St.45
DEQUANTIZATION OF DATA
St.46
PERFORM IDWT
St.347
RECIPROCAL TRANSFORMATION, REPRODUCTION OF TRAFFIC INFORMATION
St.48
REFLECT THE TRAVEL TIME IN THE UNIT (OR EACH) SECTION INTO THE LOCAL SYSTEM (REFLECT LINK COST, etc.)
St.49
V = V + 1
St.50
ARE ALL TRAFFIC-INFORMATION-PROVIDED SECTIONS COMPLETE?
NO
YES
St.51
UTILIZE THE PROVIDED TRAVEL TIME (DISPLAY OF THE REQUIRED TIME AND ROUTE GUIDANCE)
END

FIG. 46

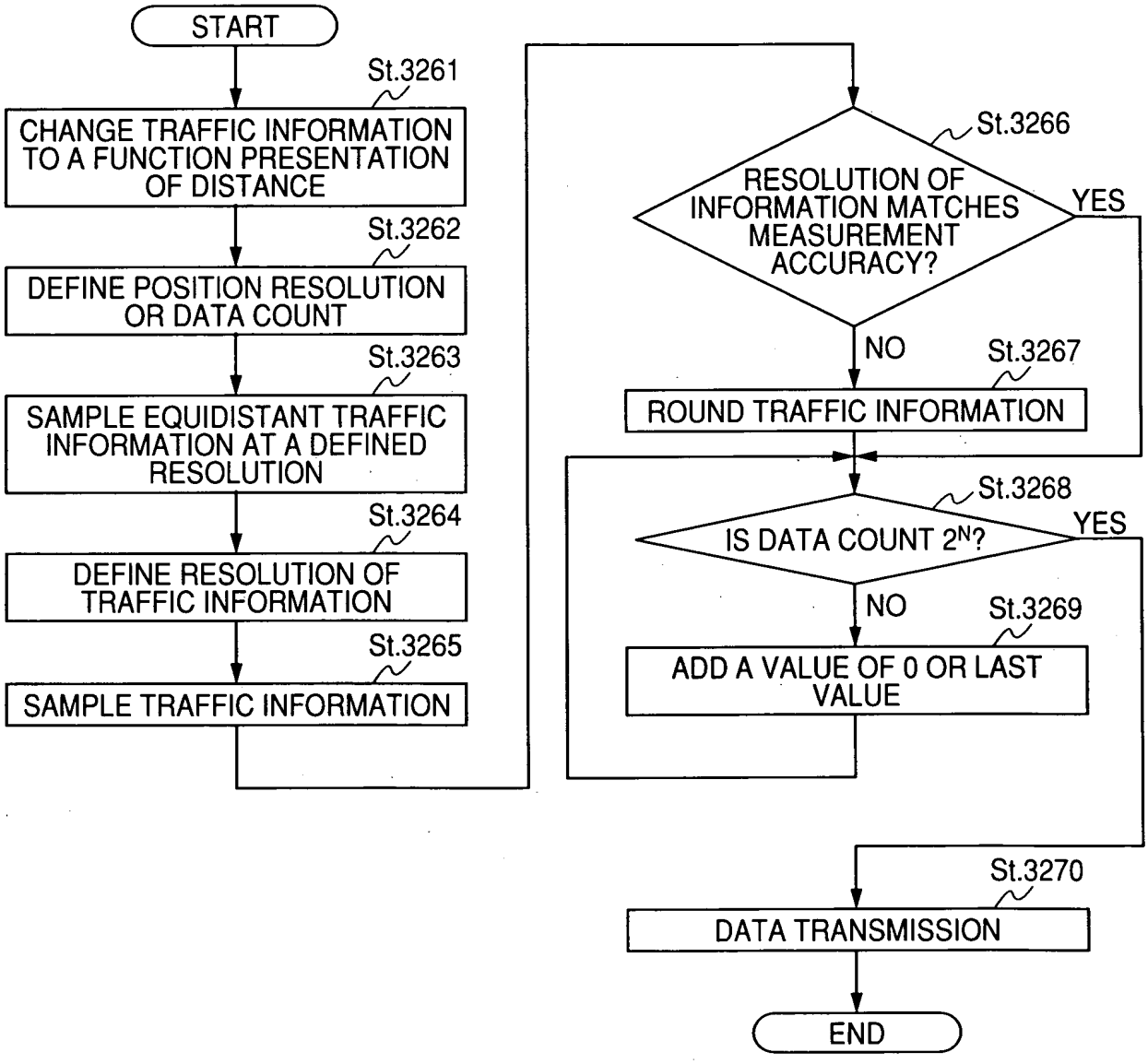

START
St.3261
CHANGE TRAFFIC INFORMATION TO A FUNCTION PRESENTATION OF DISTANCE
St.3262
DEFINE POSITION RESOLUTION OR DATA COUNT
St.3263
SAMPLE EQUIDISTANT TRAFFIC INFORMATION AT A DEFINED RESOLUTION
St.3264
DEFINE RESOLUTION OF TRAFFIC INFORMATION
St.3265
SAMPLE TRAFFIC INFORMATION
St.3266
RESOLUTION OF INFORMATION MATCHES MEASUREMENT ACCURACY?
YES
NO
St.3267
ROUND TRAFFIC INFORMATION
St.3268
IS DATA COUNT 2N?
YES
NO
St.3269
ADD A VALUE OF 0 OR LAST VALUE
St.3270
DATA TRANSMISSION
END

FIG. 47

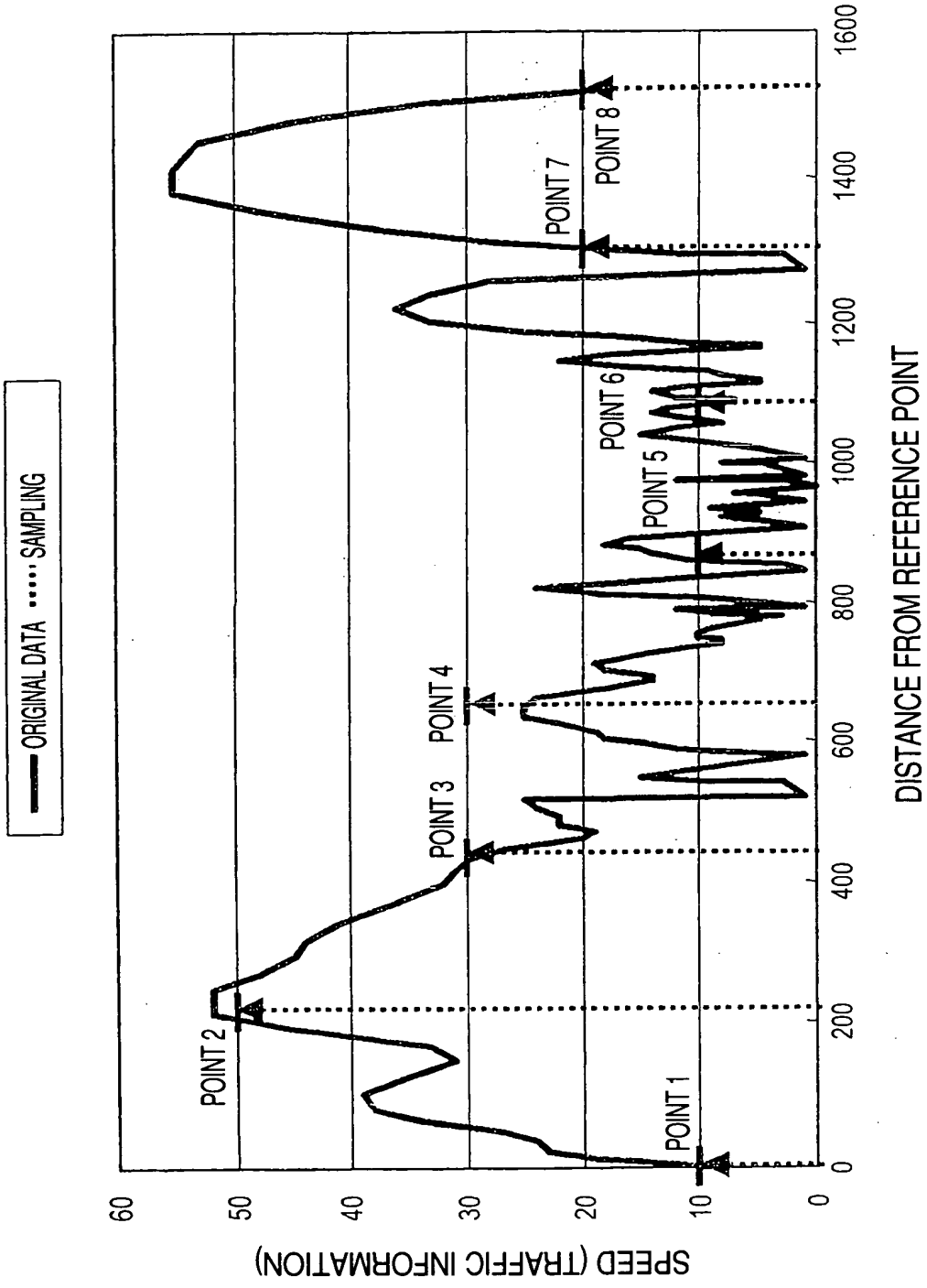

ORIGINAL DATA
SAMPLING
SPEED (TRAFFIC INFORMATION)
DISTANCE FROM REFERENCE POINT
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
1600
POINT 1
POINT 2
POINT 3
POINT 4
POINT 5
POINT 6
POINT 7
POINT 8

FIG. 48

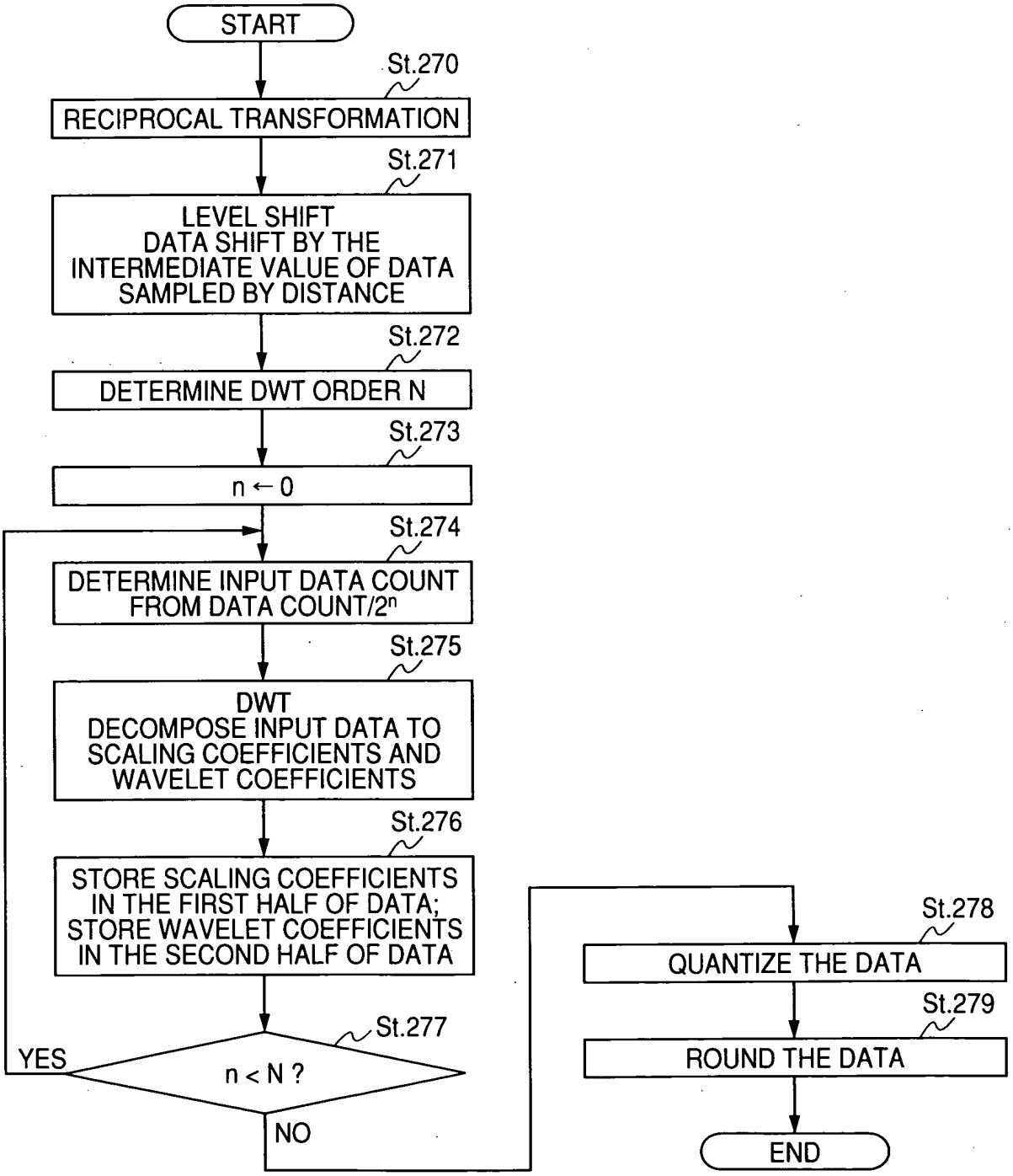

START
St.270
RECIPROCAL TRANSFORMATION
St.271
LEVEL SHIFT
DATA SHIFT BY THE INTERMEDIATE VALUE OF DATA SAMPLED BY DISTANCE
St.272
DETERMINE DWT ORDER N
St.273
n ← 0
St.274
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^n
St.275
DWT
DECOMPOSE INPUT DATA TO SCALING COEFFICIENTS AND WAVELET COEFFICIENTS
St.276
STORE SCALING COEFFICIENTS IN THE FIRST HALF OF DATA; STORE WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.277
n < N ?
YES
NO
St.278
QUANTIZE THE DATA
St.279
ROUND THE DATA
END

FIG. 49

(CONT.)

(a) SAMPLING	(a) CUMULATIVE DISTANCE	(a) QUANTIZATION SAMPLE	(b) ORIGINAL DATA SPEED	(c) ORIGINAL DATA 1/SPEED	(d) DATA SHIFT 1/SPEED-1700	(e) WAVELET TRANSFORM (6) 1/SPEED-1700
0	0.00	1	9.00	555.5555556	-1144.444444	-9188.784526
1	24.11	1	23.08	216.6437414	-1483.356259	-1579.714647
2	48.22	1	26.81	186.5284974	-1513.471503	-1100.276062
3	72.33	1	36.08	138.5681293	-1561.431871	2176.236033
4	96.44	1	38.78	128.9222374	-1571.077763	196.5703883
5	120.56	1	36.21	138.0973257	-1561.902674	-119.4436122
6	144.67	1	31.95	156.4828614	-1543.517139	-156.5281989
7	168.78	1	33.83	147.8179259	-1552.182074	994.5665895
8	192.89	1	45.02	111.0621419	-1588.937858	185.9604473
9	217.00	1	52.00	96.15384615	-1603.846154	-25.29092496
10	241.11	1	52.00	96.15384615	-1603.846154	-966.5957462
11	265.22	1	49.00	102.0307571	-1597.969243	586.862379
12	289.33	1	45.71	109.3892434	-159.0610757	981.3520643
13	313.44	1	44.16	113.2204941	-1586.779506	1891.177026
14	337.56	1	41.32	121.0101719	-1578.989828	-1128.029468
15	361.67	1	37.51	133.3142202	-1566.68578	-52.61119427
16	385.78	1	33.73	148.2513938	-1551.748606	223.5513351
17	409.89	1	31.24	160.041841	-1539.958159	-18.64061207
18	434.00	1	29.44	169.85138	-1530.14862	4.515692407
19	458.11	1	21.81	229.2020374	-1470.797963	-15.8573273
20	482.22	1	22.00	227.2727273	-1472.727273	-45.38009129
21	506.33	1	24.10	207.4468085	-1492.553191	-1285.926604
22	530.44	1	1.91	2620.253165	920.2531646	1149.080803
23	554.56	1	12.94	386.3195791	-1313.680421	-156.3986276
24	578.67	1	2.05	2434.554974	734.5549738	294.9688122
25	602.78	1	17.48	286.1035422	-1413.896458	-809.2368538
26	626.89	1	22.47	222.4969098	-1477.50309	1223.592888
27	651.00	1	25.00	200	-1500	102.0126353
28	675.11	1	18.87	264.9456522	-1435.054348	134.8900328
29	699.22	1	15.61	320.2846975	-1379.715302	1608.288909
30	723.33	1	15.87	315.1260504	-1384.87395	11.29441715
31	747.44	1	8.58	582.9015544	-1117.098446	-68.8800294
32	771.56	1	6.18	809.352518	-890.647482	239.646842
33	795.67	1	2.11	2368.421053	668.4210526	33.9131015
34	819.78	1	22.79	219.4148936	-1480.585106	-6.487767193
35	843.89	1	2.11	2368.421053	668.4210525	6.127034682
36	868.00	1	13.14	380.4347826	-1319.565217	10.54175703
37	892.11	1	16.38	305.2917232	-1394.708277	-4.155603581
38	916.22	1	3.77	1327.868852	-372.1311475	-2.709103324
39	940.33	1	5.12	976.3313609	-723.6686391	-8.700275999
40	964.44	1	1.83	2739.130435	1039.130435	-8.33710516
41	988.56	1	2.31	2167.13881	467.1388102	-41.96725225
42	1012.67	1	2.41	2074.468085	374.4680851	14.0190416
43	1036.78	1	13.00	384.6153846	-1315.384615	1579.629587
44	1060.89	1	8.78	569.6202532	-1130.379747	1519.184576
45	1085.00	1	9.25	540.5405405	-1159.459459	15.90771745
46	1109.11	1	11.38	439.3305439	-1260.669456	-39.13061422
47	1133.22	1	10.71	466.8049793	-1223.195021	-189.3458747
48	1157.33	1	17.28	289.3890675	-1410.610932	-1102.427933
49	1181.44	1	18.28	273.4638758	-1426.536124	-1519.576828
50	1205.56	1	33.56	148.9806587	-1551.019341	53.13416687
51	1229.67	1	34.70	144.092219	-1555.907781	248.5745441
52	1253.78	1	29.24	170.9879303	-1529.01207	404.4591565
53	1277.89	1	1.44	3461.538462	1761.538462	1194.906304
54	1302.00	1	18.43	271.3178295	-1428.682171	20.56246199
55	1326.11	1	35.06	142.6307448	-1557.369255	-19.42735952
56	1350.22	1	45.24	110.5248795	-1589.475121	11.26081109
57	1374.33	1	52.85	94.60141271	-1605.398587	3.456648813
58	1398.44	1	55.00	90.90909091	-1609.090909	-2326.770595
59	1422.56	1	54.57	91.62836698	-1608.371633	90.99551018
60	1446.67	1	53.19	94.00179051	-1605.998209	11.25959132
61	1470.78	1	47.46	105.3535196	-1594.64648	-0.508604986
62	1494.89	1	37.23	134.2934994	-1565.706501	-8.026884609
63	1519.00	1	24.65	202.8218695	-1497.178131	-48.45687518

RECIPROCAL TRANSFORMATION

LEVEL SHIFT

DWT

(FIG. 49 CONTINUED)

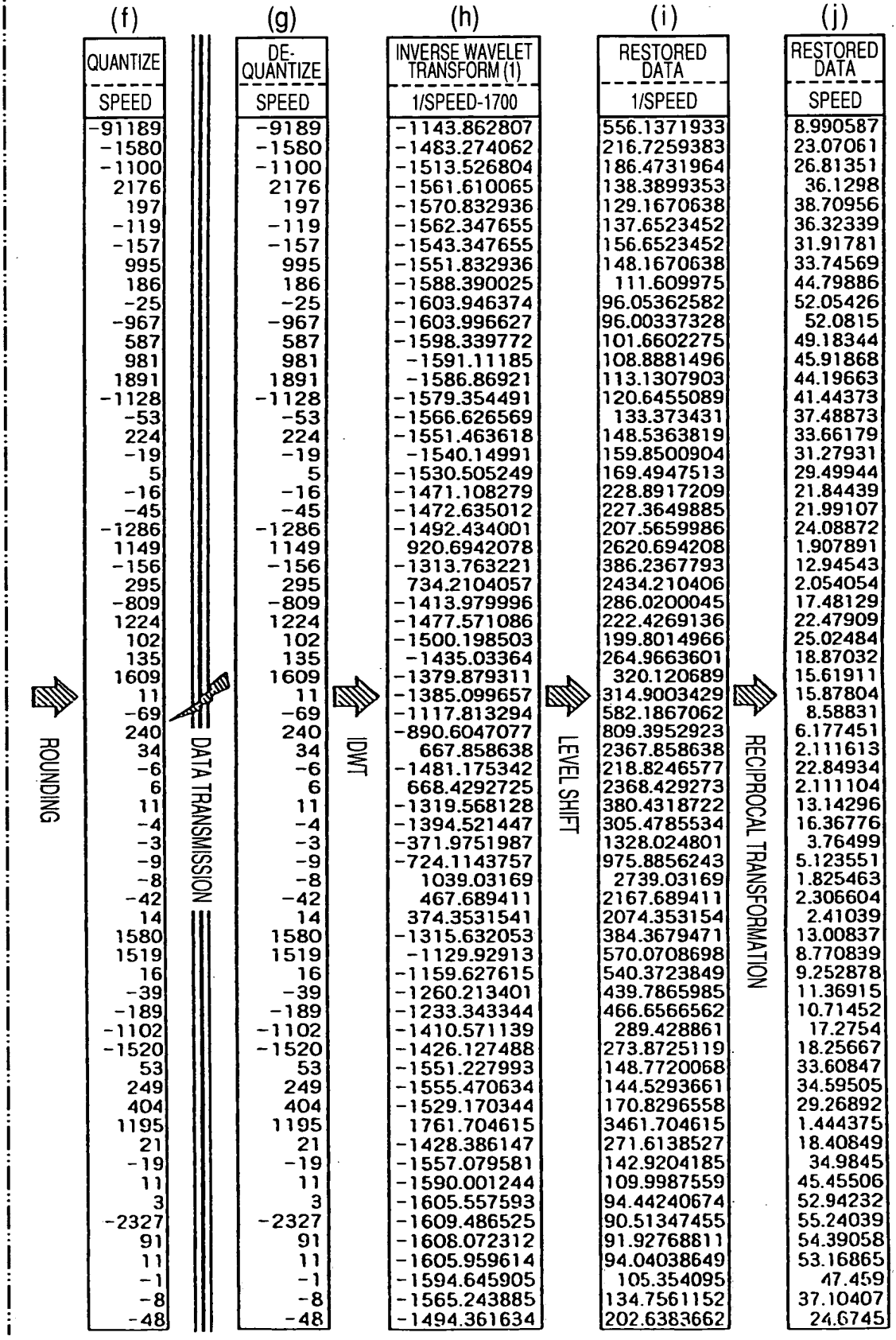


FIG. 50

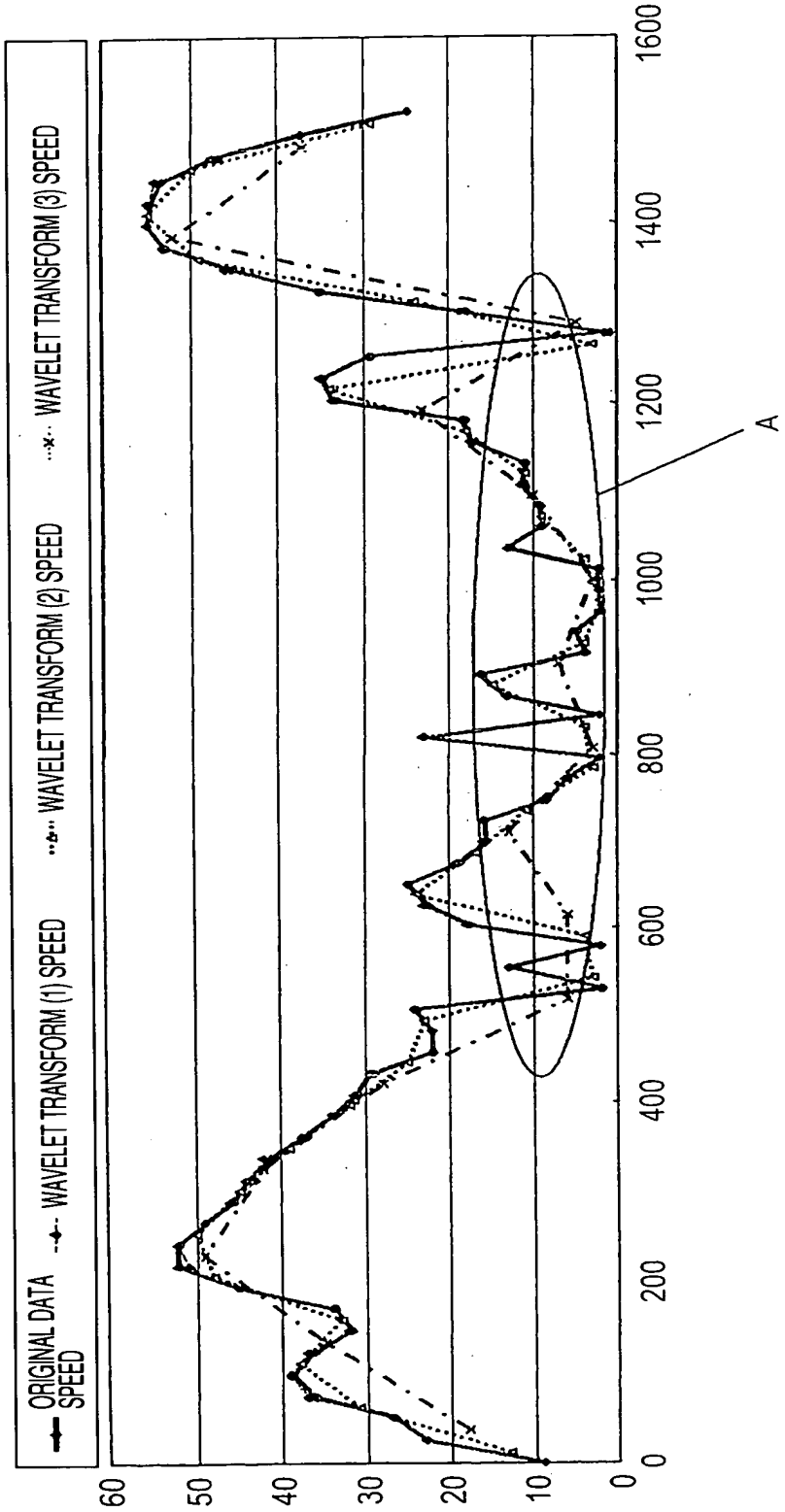

ORIGINAL DATA SPEED
WAVELET TRANSFORM (1) SPEED
WAVELET TRANSFORM (2) SPEED
WAVELET TRANSFORM (3) SPEED
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
A

FIG. 51

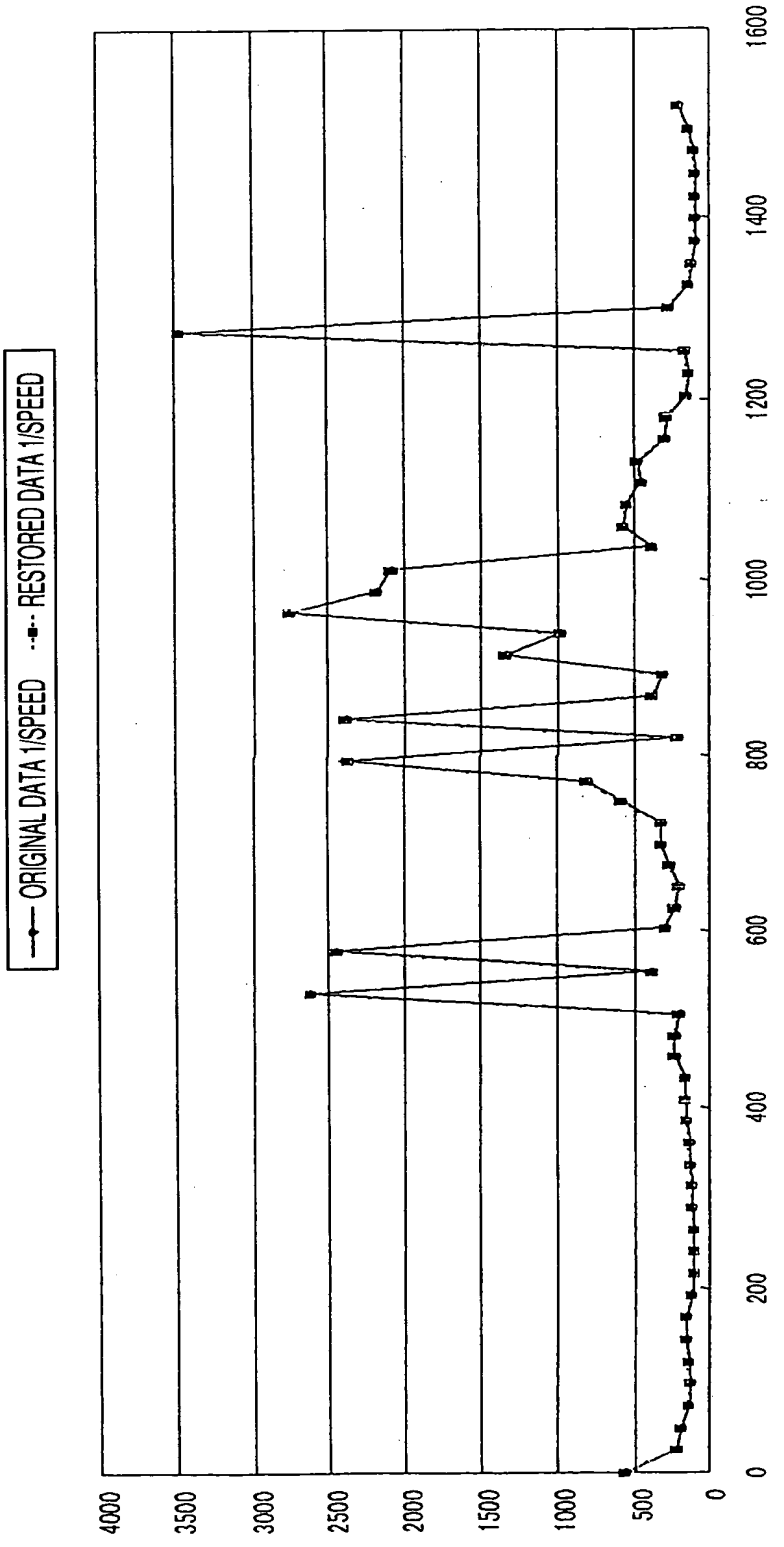

ORIGINAL DATA 1/SPEED
RESTORED DATA 1/SPEED
4000
3500
3000
2500
2000
1500
1000
500
0
0
200
400
600
800
1000
1200
1400
1600

FIG. 52

(a) SHAPE VECTOR DATA STRING

SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
VECTOR DATA TYPE (= ROAD)
TOTAL NUMBER OF NODES
NODE NUMBER P_1
NODE 1X DIRECTION ABSOLUTE COORDINATE (LONGITUDE)
NODE 1Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE)
NODE 1 ABSOLUTE BEARING
≀
NODE NUMBER P_n
NODE N RELATIVE COORDINATE (X_n)
NODE N RELATIVE COORDINATE (Y_n)
NODE N RELATIVE BEARING
≀ ≀
SHAPE VECTOR STRING IDENTIFICATION NUMBER = 100
≀ ≀
SHAPE VECTOR STRING IDENTIFICATION NUMBER = ZZ
≀ ≀

(b) TRAFFIC INFORMATION DATA STRING

SCALING COEFFICIENT IDENTIFICATION FLAG
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DATA COUNT N_a
VALID DATA COUNT N_b
VALID BLOCK LENGTH | LEVEL SHIFT
FINAL ORDER OF DWT N
NTH-ORDER SCALING COEFFICIENT 1
≀
NTH-ORDER SCALING COEFFICIENT $N_a/2^N$
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 100
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = ZZ
≀ ≀

(c)

WAVELET COEFFICIENT IDENTIFICATION FLAG
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DWT ORDER N
NTH-ORDER WAVELET COEFFICIENT 1
≀
NTH-ORDER WAVELET COEFFICIENT $N_a/2^N$
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 100
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = ZZ
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = 1
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DWT ORDER n
nTH-ORDER WAVELET COEFFICIENT 1
≀
nTH-ORDER WAVELET COEFFICIENT $N_a/2^n$
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = ZZ
≀ ≀
SHAPE VECTOR DATA IDENTIFICATION NUMBER = Z
DIRECTION IDENTIFICATION FLAG (FORWARD/BACKWARD)
INFORMATION TYPE (SPEED/CONGESTION RANK/TRAVEL TIME)
DWT ORDER 1
FIRST-ORDER WAVELET COEFFICIENT 1
≀
FIRST-ORDER WAVELET COEFFICIENT $N_a/2$
≀ ≀

FIG. 53

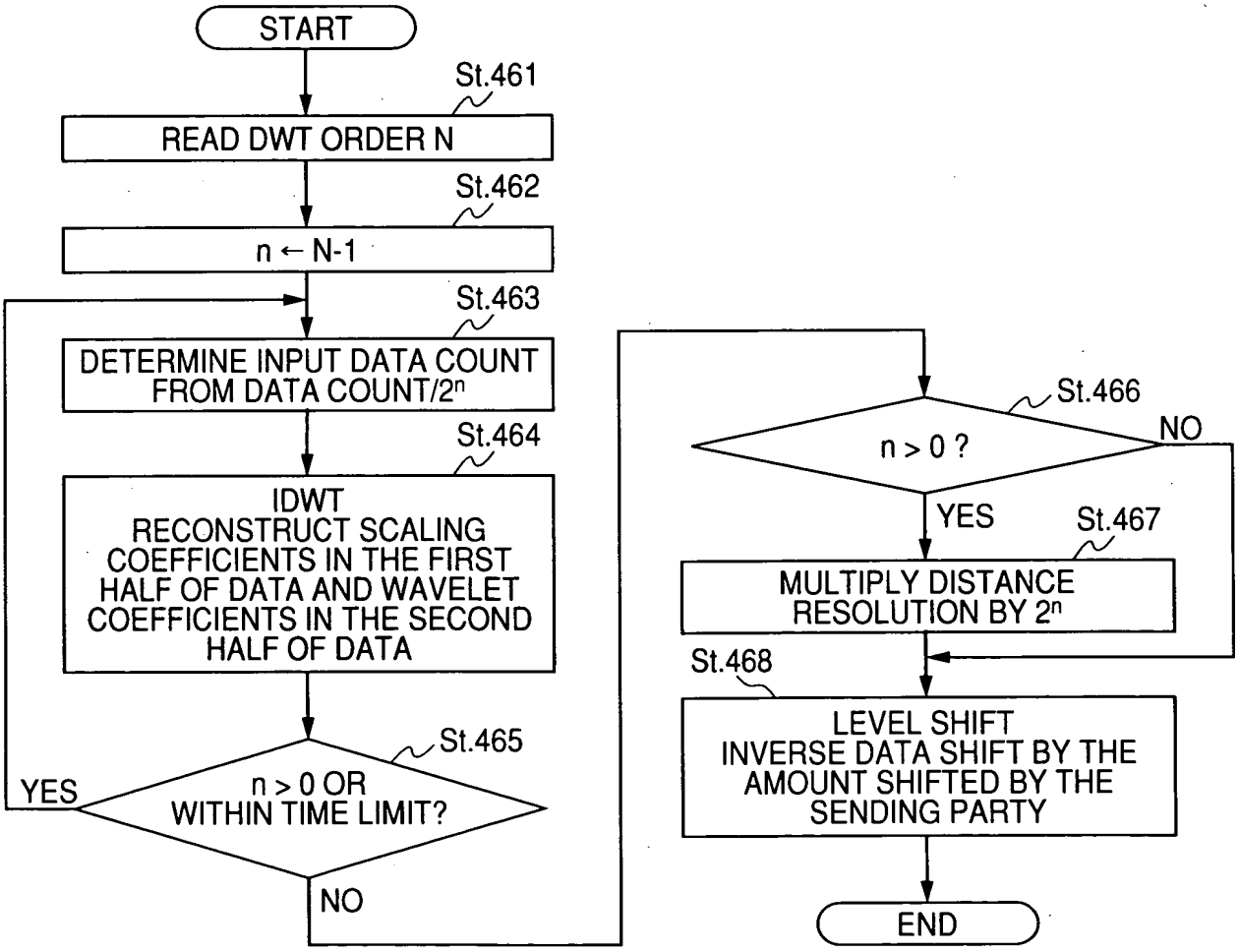

START
St.461
READ DWT ORDER N
St.462
n ← N-1
St.463
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2n
St.464
IDWT
RECONSTRUCT SCALING COEFFICIENTS IN THE FIRST HALF OF DATA AND WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.465
n > 0 OR WITHIN TIME LIMIT?
YES
NO
St.466
n > 0 ?
NO
YES
St.467
MULTIPLY DISTANCE RESOLUTION BY 2n
St.468
LEVEL SHIFT
INVERSE DATA SHIFT BY THE AMOUNT SHIFTED BY THE SENDING PARTY
END

FIG. 54

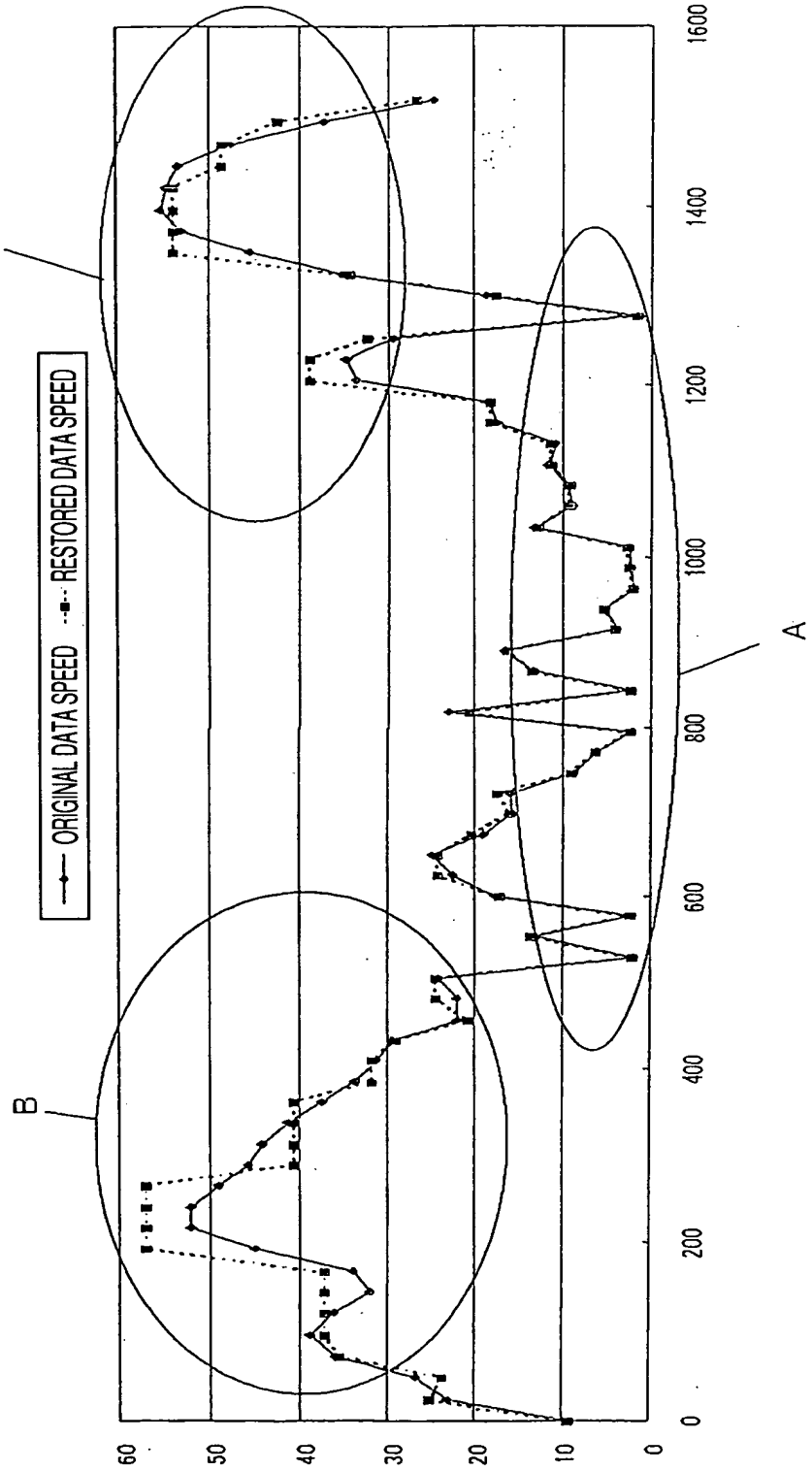

ORIGINAL DATA SPEED
RESTORED DATA SPEED
A
B
C
0
200
400
600
800
1000
1200
1400
1600
0
10
20
30
40
50
60

FIG. 55(a)

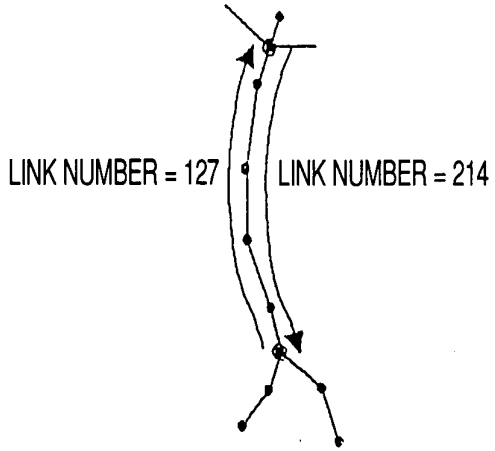


FIG. 55(b)

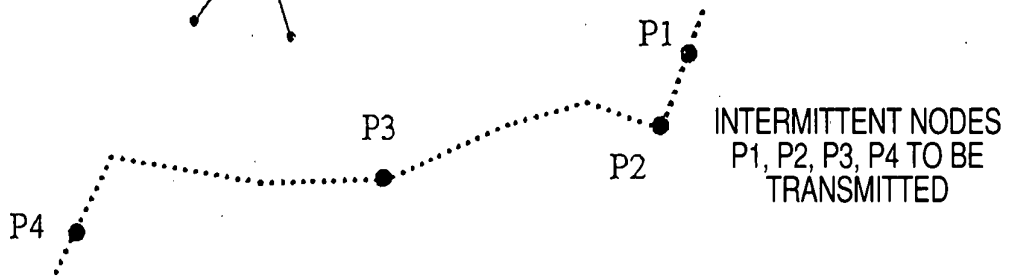


FIG. 55(c)

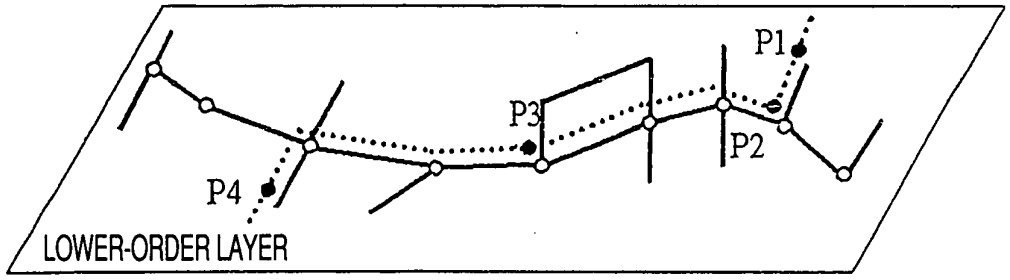


FIG. 56

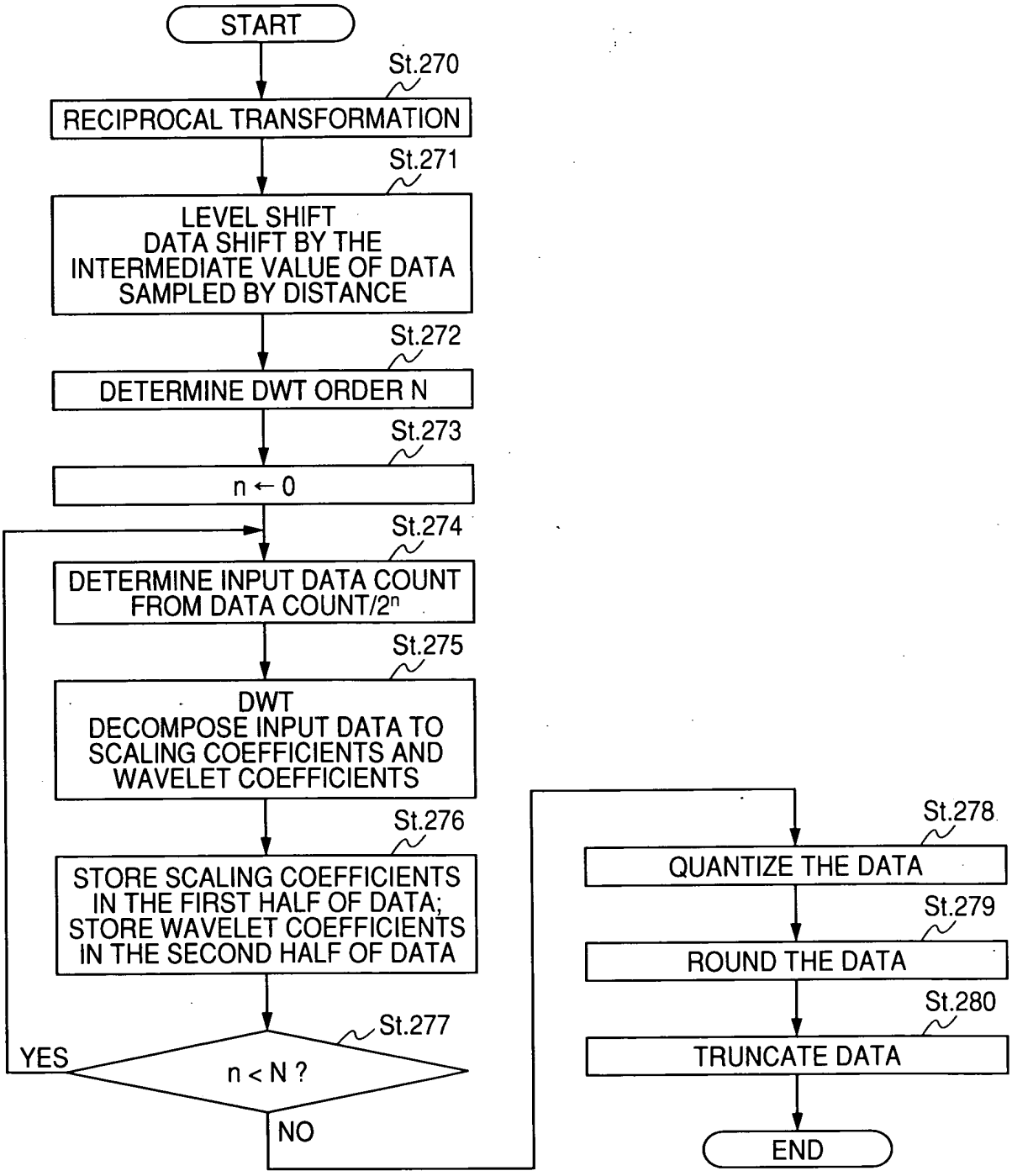

START
St.270
RECIPROCAL TRANSFORMATION
St.271
LEVEL SHIFT
DATA SHIFT BY THE INTERMEDIATE VALUE OF DATA SAMPLED BY DISTANCE
St.272
DETERMINE DWT ORDER N
St.273
n ← 0
St.274
DETERMINE INPUT DATA COUNT FROM DATA COUNT/2^n
St.275
DWT
DECOMPOSE INPUT DATA TO SCALING COEFFICIENTS AND WAVELET COEFFICIENTS
St.276
STORE SCALING COEFFICIENTS IN THE FIRST HALF OF DATA; STORE WAVELET COEFFICIENTS IN THE SECOND HALF OF DATA
St.277
n < N ?
YES
NO
St.278
QUANTIZE THE DATA
St.279
ROUND THE DATA
St.280
TRUNCATE DATA
END

FIG. 57

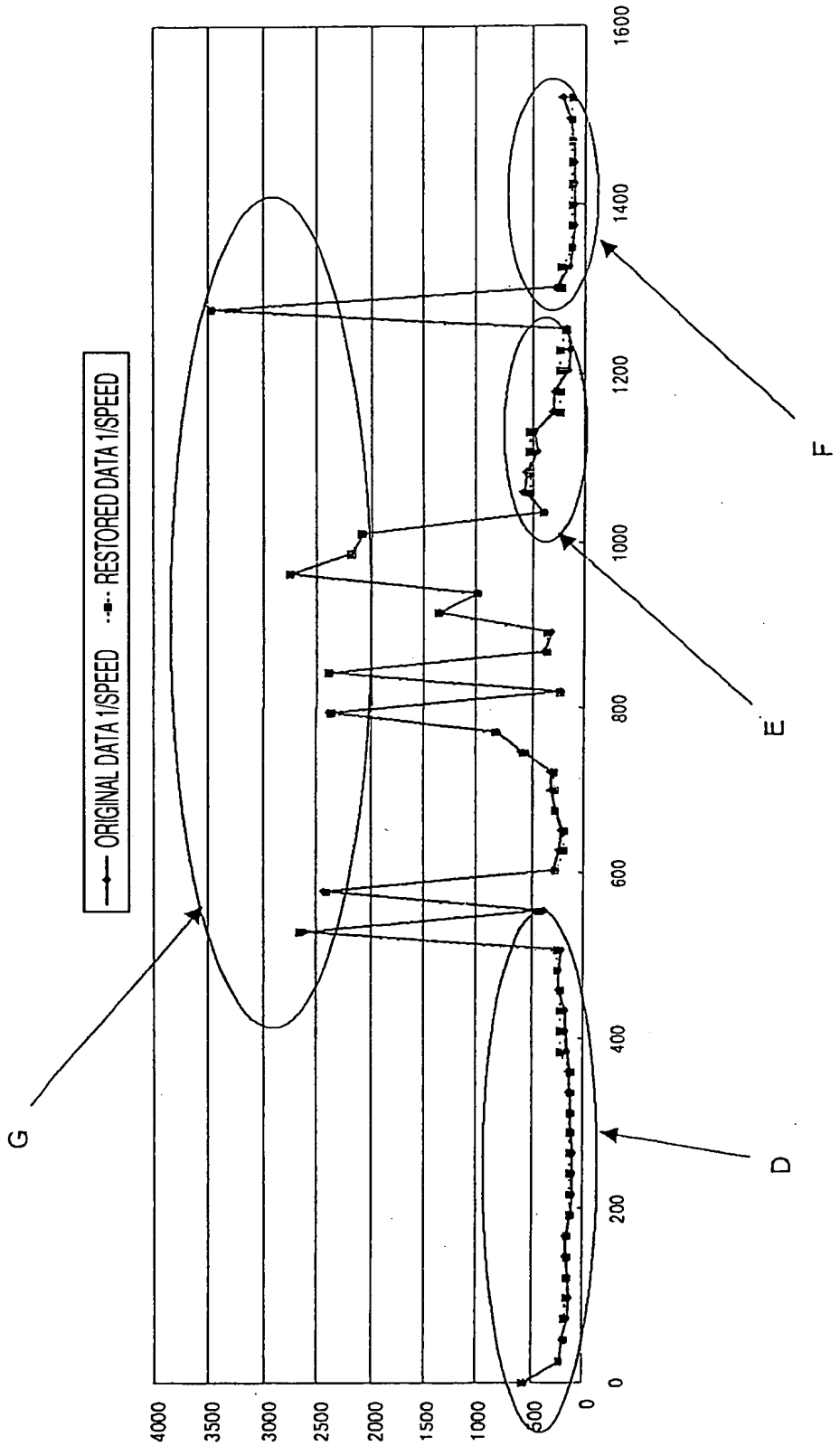

ORIGINAL DATA 1/SPEED
RESTORED DATA 1/SPEED
4000
3500
3000
2500
2000
1500
1000
600
0
1600
1400
1200
1000
800
600
400
200
0
G
D
E
F

FIG. 58

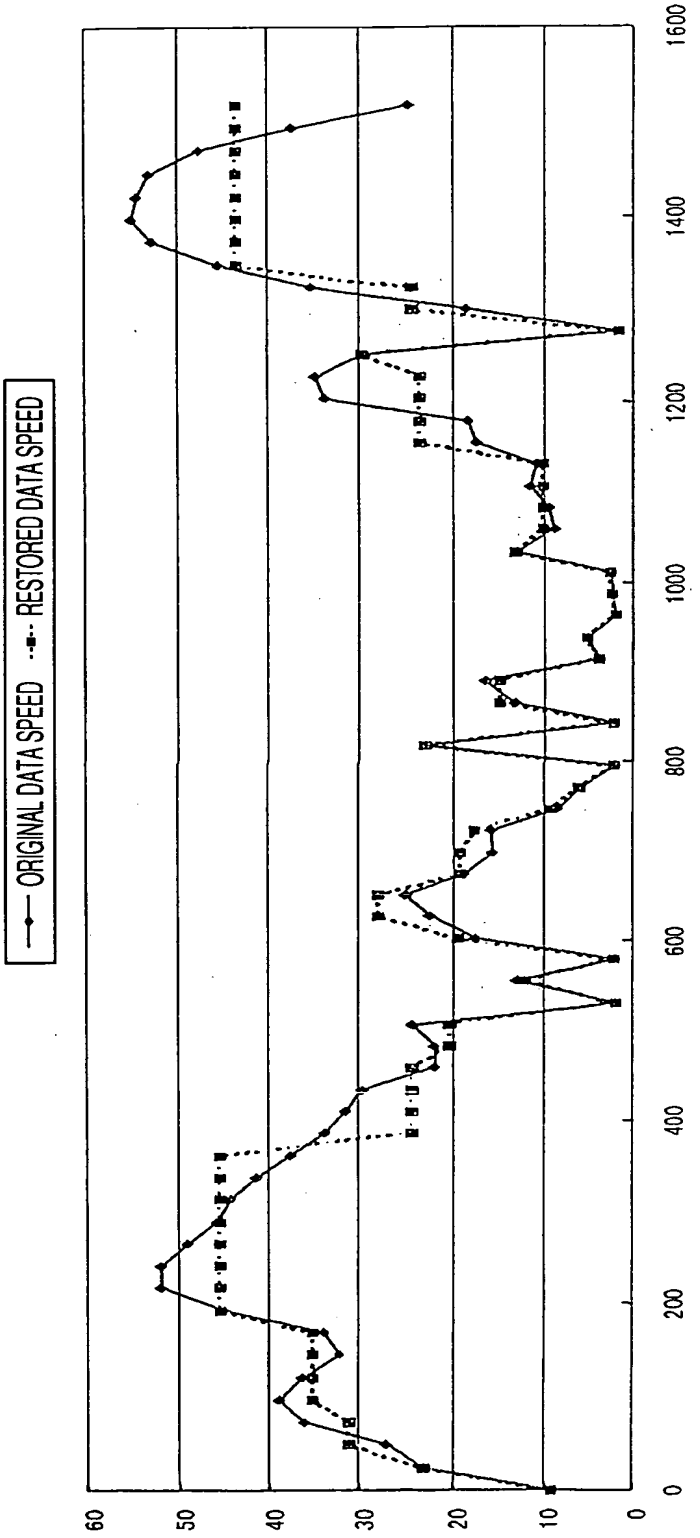
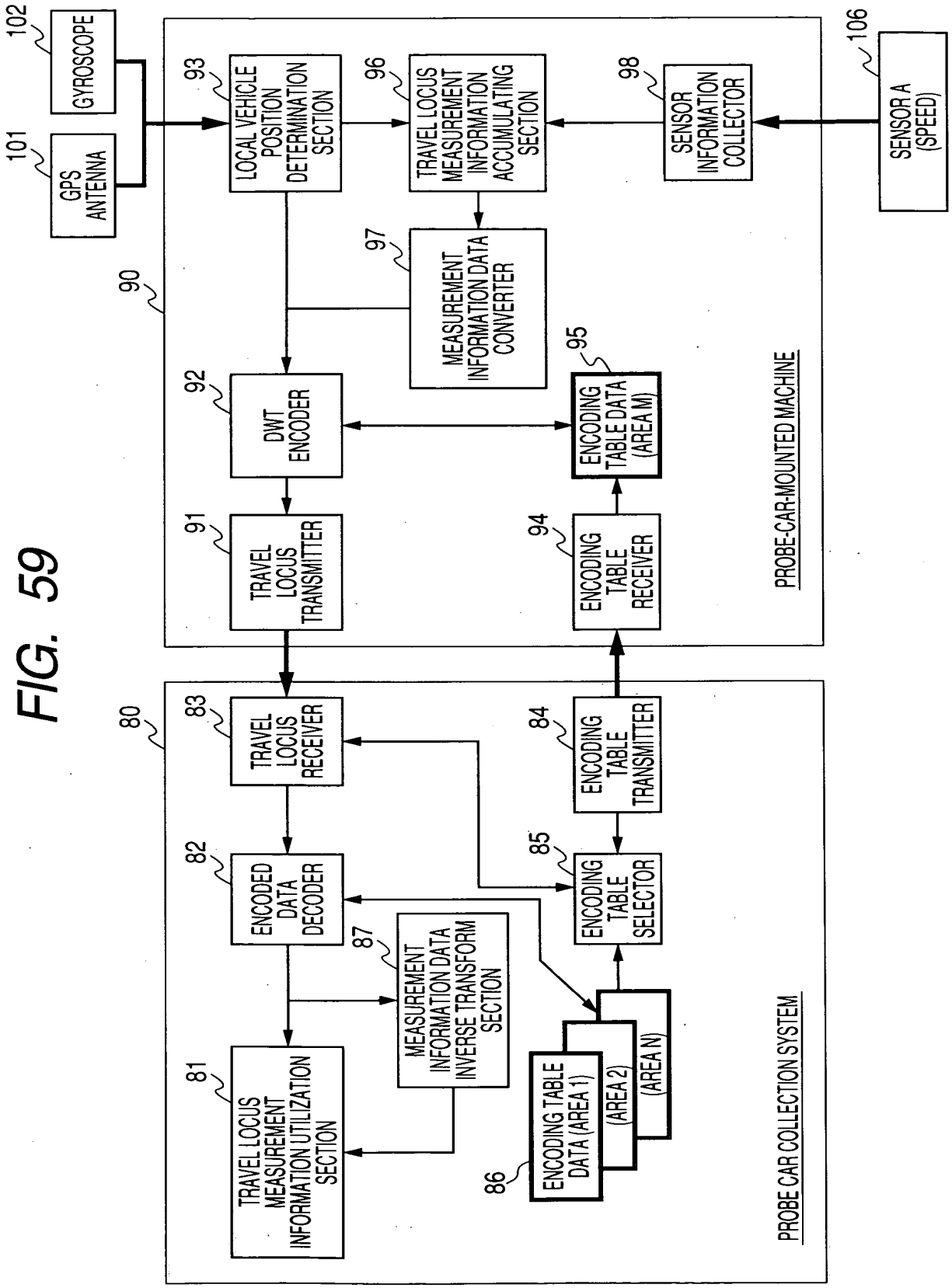

ORIGINAL DATA SPEED
RESTORED DATA SPEED
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600

FIG. 59


102
GYROSCOPE
101
GPS ANTENNA
93
LOCAL VEHICLE POSITION DETERMINATION SECTION
96
TRAVEL LOCUS MEASUREMENT INFORMATION ACCUMULATING SECTION
98
SENSOR INFORMATION COLLECTOR
106
SENSOR A (SPEED)
97
MEASUREMENT INFORMATION DATA CONVERTER
90
92
DWT ENCODER
95
ENCODING TABLE DATA (AREA M)
91
TRAVEL LOCUS TRANSMITTER
94
ENCODING TABLE RECEIVER
PROBE-CAR-MOUNTED MACHINE
80
83
TRAVEL LOCUS RECEIVER
84
ENCODING TABLE TRANSMITTER
82
ENCODED DATA DECODER
85
ENCODING TABLE SELECTOR
87
MEASUREMENT INFORMATION DATA INVERSE TRANSFORM SECTION
81
TRAVEL LOCUS MEASUREMENT INFORMATION UTILIZATION SECTION
86
ENCODING TABLE DATA (AREA 1)
(AREA 2)
(AREA N)
PROBE CAR COLLECTION SYSTEM